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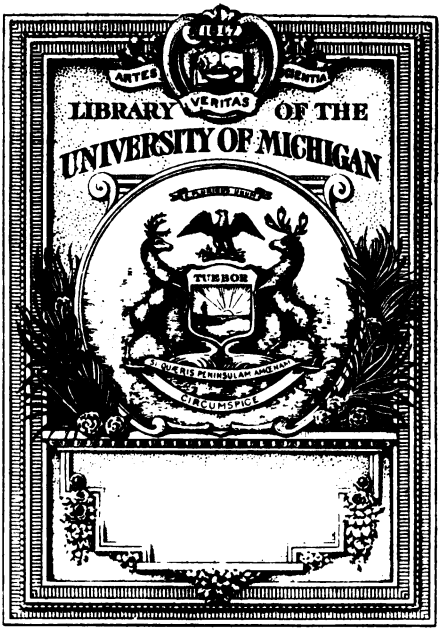
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Joseph Henry

THE

SCIENCE RECORD

FOR

1873.

A COMPENDIUM

OF

SCIENTIFIC PROGRESS

FOR THE YEAR

WITH ILLUSTRATIONS.

NEW YORK

MUNN & COMPANY, OFFICE OF THE SCIENTIFIC AMERICAN.

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SCIENTIFIC PROGRESS AND DISCOVERY

DURING THE PAST YEAR.

WITH ILLUSTRATIONS.

EDITED BY ALFRED E. BEACH.

NEW-YORK:
MUNN & COMPANY, OFFICE OF THE "SCIENTIFIC AMERICAN.
1873.

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In the Office of the Librarian of Congress, at Washington.

S. W. GREEN, Printer, 16 & 18 Jacob Street, New-York.

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PREFACE.

THIS is the age of telegrams. The public is accustomed to the consideration of useful facts set forth in the briefest terms. Were it otherwise, the editor would hesitate to place before the reader a volume like the present; for it is, of necessity, an assemblage of brevities.

The year '72, just closed, has been prolific in matters of interest pertaining to science; and the presentation of any thing like a general view of the year's progress has required that each statement should be reduced to the narrowest compass.

So far as possible, the editor has sought to employ the language of the original authors and publications that have been consulted in the preparation of the work. The catalogue at the close of the volume indicates the sources from which much of the information here given is derived; to which reference is made by numbers at the foot of the several articles.

NEW-YORK, January 1, 1873.

SCIENCE RECORD.

CHEMISTRY AND METALLURGY.

PROGRESS OF CHEMISTRY.

IT is interesting to notice that the attention bestowed upon chemistry is far above that given to any one other subject of scientific study, arising doubtless from the manner in which chemistry, owing to the numerous discoveries of the last decade, is fast becoming an integral part of other applied science. A knowledge of chemistry is now almost as essential to the engineer as to the chemist. In naval architecture, recent events have proved that the disregard of molecular action may be attended with awkward consequences; while the highest branches of chemical inquiry are brought in to aid in the improvement of the material itself of which our vessels are constructed. To enumerate the results of the application of chemistry to manufacture during the last century would be to record more brilliant triumphs than are to be found in the annals of ancient Greece and Rome. Who would not endeavor to follow, however distantly, in the footsteps of such men as Faraday, Wollaston, and others of the day whose names are household words?

Chemistry, in short, must now rank as one of the exact sciences, as it is one of the most important; and without doubt it has arrived at its present stage of advancement by means of a careful discrimination and a close attention *to fact.* (2)

GAS-PROOF LEATHER.

As a means of making leather articles capable of holding gases, Enoch Osgood proposes to immerse them in glycerine until thoroughly saturated, which, he states, will prevent the passage of air or gases through the pores of the leather.

METALLURGY OF MANGANESE.

By Hugo Tamm.—The metal obtained by this new process is not pure manganese, it is to manganese that which cast-iron is to iron, and I will henceforth call it cast-manganese. But it is prepared with common materials, and the superiority of the process consists in this, that with a given manganese ore the cast-manganese is purer than the corresponding metal extracted by another process, and lastly, it is obtained with greater facility, greater security, and at less expense than with ordinary means, and, what is most important of all, it may be prepared in unlimited quantity.

Two fluxes are required: one which I will call flux No. 1, or white flux, and which is obtained by mixing well ground glass, free from lead, 63 parts; quick-lime, 18½ parts; Fluor-spar, 18½ parts. Total, 100. This flux is the original flux from which the others are made, but it is used also *per se*, to add to the fusibility of the others. The second flux is the following: Flux No. 1, 34 parts; lamp-black, or soot of good quality, 5½ parts; peroxide of manganese, native, of good quality, 60½ parts. Total, 100 parts. Flux No. 3—17½ parts of cast-manganese are obtained, and the slag, which presents a fine olive-green color, is ground. It is saturated with protoxide of manganese, to which it owes its color, and it forms an admirable flux, either for the smelting of manganese ores or for their docimastic assaying. I design the flux thus prepared as flux No. 3, or green flux.

When once this green flux has been obtained, the extraction of manganese presents no further difficulty, because it can be used over and over again, providing the oxide of manganese produced is of a tolerably good quality, and introduces no injurious material in its slag.

At the high temperature required for the smelting of manganese, no crucibles could stand the flux, and they were all destroyed. I tried pots of every description, even the best plumbago crucibles, but none would stand the molten flux. But the following plan which I devised is so simple and so effective that not only is every difficulty removed, but special advantages are attached to its use.

Three parts of plumbago, and one part of loam or fire-clay are mixed together, and made into a thick paste with water, and the crucible is as equally as possible lined with this paste, which holds firmly to its sides. The thickness of the lining varies with the size of the crucible, but with the largest crucibles it should not exceed half an inch.

The following mixture is introduced into the crucible: Native oxide of manganese of good quality, 1000 parts; lamp-black, or soot of good quality, 91 parts; green flux, 635 parts; oil, in sufficient quantity to merely wet the mixture.

Any kind of oil is good enough for the purpose. The mixture must be made shortly before introducing into the crucible; for if it is left standing for some hours, especially in an open vessel, it is apt to catch fire.

The mixture is introduced in the crucible and slightly pressed in, and a round cover of thick wood is placed over it. It is carbonized during the smelting, and forms a charcoal cover, which protects admirably the mixture from oxidation, and it can be used several times.

The clay or plumbago cover is then placed over the crucible, and the joint is luted with a little thin fire-clay. A small aperture is kept to allow the gases to escape.

The crucible is then placed in a wind or blast-furnace, and slowly heated so long as fumes escape from the crucible. The heat is then rapidly increased until it reaches white heat, and the furnace is maintained at that high temperature for several hours, the time required depending, of course, on the quantities operated upon.

When it is thought that the operation is done, the fire is allowed to burn away and the crucible is left to cool. The cover is then removed by means of a chisel introduced in the joint. The crucible is turned upside down, and shaken until the slag and metal fall down. The button of metal is detached from its slag with a hammer, and introduced in well-corked or stoppered vessels perfectly dried.

The slag, which has a fine olive-green color, breaks up in fragments with large faces affecting a pseudo-crystalline structure, but the grain is really crystalline. It is ground and used as flux in a second smelting. It is advisable after each smelting to add to the slag, in order to make it more fusible, about 1-10th of the white flux.

The mixing of manganese ore, lamp-black, and flux is not an indifferent operation, and to insure perfect success, it should be done in the following way: The oxide of manganese should be first of all thoroughly mixed with the lamp-black. Then this mixture should be pretty roughly mixed with the flux, and then oil should be added. By so doing, lamp-black and oxide of manganese remain united during the mixing, and act upon each other during the smelting, before the flux begins to melt, so that the oxide is reduced to the metallic state before the flux can dissolve any portion of it. The residue of carbon

left by the burnt oil assists in reducing the oxide of manganese, and in preventing the flux from acting upon it before it has been reduced to the metallic state.

It is almost an extraordinary thing that, according to the manner in which substances have been mixed, their chemical reactions should differ; but it must be borne in mind that, in docimastic or metallurgical operations, several successive chemical reactions take place at intervals. Hence the real importance of a systematic way of mixing.

There is little doubt that, as soon as manganese is prepared on the large scale and at a comparatively low price, some uses will be found for it. I think that, in certain operations, it might form a good substitute for potassium and sodium; and in that case cast-manganese, such as is obtained after the smelting of its ore, could be used with advantage; but, should a purer kind of metal be required for the manufacture of certain special alloys, cast-manganese would have to be refined.

The simplest way of refining manganese is the method which has been proposed by Berthier, I believe, and which consists in re-melting the cast-manganese coarsely powdered with about one eighth of carbonate of manganese. The mixture is introduced into a refractory clay crucible, and covered over with a wooden cover similar to the one used in the smelting, to prevent oxidation.

Cast-manganese, refined by carbonate of manganese, presented the following composition: Manganese, 99·910; iron, 0·050; silicium, 0·015; carbon, 0·025; other substances, traces. Total, 100·000. (2)

ARTIFICIAL BUTTER.

By Mige Mouriez.—Some years ago, the author was requested by the Victualing Department of the French Navy to try to find a wholesome substitute for butter, which would not become rancid by keeping. Experiments made with cows, submitted to a very severe and scanty diet, led to the discovery that these animals continued to give milk, although in very much smaller quantity, and that this milk always contained butter; the author surmised that this butter was due to the absorption of the fat contained in the animal tissues, which was converted into butter under the influence of the milk-secreting glands. This led to experiments on the splitting up of animal fats, and, further, to the following process for making butter artificially. Best fresh beef-suet is first mechanically cut up, by means of circular saws fitted to a cylinder, and is next placed in a

vessel containing water, carbonate of potassa, and fresh sheep's stomachs previously cut up into small fragments; the temperature of this mixture having been raised to 45°, the joint influence of the pepsine of the stomachs and heat causes the fat to be separated from the cellular tissue; the fatty matter floating on the top is decanted, and, after cooling, submitted to very powerful hydraulic pressure; the stearine is used in candle-making, and the semi-fluid oleomargarine is used for making the artificial butter in the following manner: 50 kilos. of the fat are poured, along with 25 litres of milk and 20 litres of water, into a churn, while there is added 100 grms. of the soluble matter obtained by soaking for some hours in milk from cows' udders and milk-glands; a small quantity of annatto is also added, and the operation of churning then proceeded with. The butter thus obtained is well washed with cold water, and, if required to be kept for a long time, melted by a gentle heat, to eliminate all the water. According to reports of sanitary committees, as well as of the authorities of the Victualing Department of the French Navy, this artificial butter is really an excellent substitute for genuine butter, and can be exposed for sale if the vessels are marked to distinguish the artificial from the genuine butter. (2)

GOLD FROM SEA-WATER.

THE proportion of gold contained in sea-water (certainly less than one grain in the ton) is much too small to admit of separation, or even detection, by the usual tests applied in the usual manner.

The method I shall describe of detecting gold in sea-water may be practised upon so small a quantity of water as 150 or 200 c.c. Two or three decigrammes of pure ferrous sulphate are dissolved in the water, which is acidulated by two or three drops of hydrochloric acid. The solution is heated in a *chemically clean* and well-glazed porcelain dish, over a small flame, so managed that the flame may touch the under part of the dish without causing ebullition. Under these circumstances, a lustrous film of ferric oxide forms in the dish, commencing from the portion directly heated by the flame. The heat is continued, without boiling, until the sea-water is evaporated to about half, or so long as the film increases in extent and in lustre. The liquid is then poured off, the strongly adherent film is rinsed with a little water, and then about 50 c.c. of strong chlorine water is allowed to stand in the dish for an hour or two, after which it is slowly evaporated down (over the film) to a few drops, a

drop of dilute hydrochloric acid being added toward the end of the evaporation. The liquid, which should be nearly colorless, is then poured into a test-glass containing a few drops of solution of stannous chloride, when, after a few minutes, the liquid takes a bluish or purplish tint, which may be exactly matched by a drop or two of a suitably diluted solution of gold added to a corresponding portion of tin-salt in another glass. The reaction may, of course, be made more striking by taking for the experiment a larger quantity of sea-water, although the reaction obtainable from the quantity indicated is quite definite. I have repeated this experiment many times, upon different specimens of sea-water, and always with the same result when a *film* was obtained on evaporation. But the formation of this film depends upon the iron being in a particular degree of oxidation, and I have sometimes failed to obtain it. The best way is, after adding the ferrous sulphate and hydrochloric acid to the sea-water, to leave it exposed to the air for a few hours, or over night, before heating the liquid to obtain the film. Corresponding experiments were made, in the same vessels and with the same reagents, upon simple water, and upon water containing chloride of sodium and alkali sulphates in solution, but the films obtained, when treated as described, never gave the slightest coloration with solution of stannous chloride. The chlorine solution off the sea-water films may be dried up in a porcelain crucible with precipitated lead, and gold beads obtained by cupellation, after fusing the lead into a button with borax; but for this experiment at least half a litre of sea-water should be taken, and even then the bead obtained is not ponderable.

(2) E. SONSTADT.

ELECTROLYSIS OF WATER.

BY C. J. WOODWARD, B.SC.—The extremely convenient arrangement of Dr. Hofmann for showing the composition of water by electrolysis is, owing to its first cost and delicate construction, only accessible to those who are able to make a considerable expenditure in apparatus. The modification I have used is as follows: A glass cylindrical vessel, about 5 centimetres diameter and about 6 centimetres high, has ground into it a stopper in which are three holes, each hole being about 15 mm. diameter. In two of these holes are fitted the tubes intended for the reception of the gases, oxygen and hydrogen, whilst the remaining hole serves to insert a third tube to contain the acid expelled as the gases are formed. The tubes for collecting the gases have elec-

trodes made by cutting strips of platinum foil, which are cemented lengthwise on the tube and hang a centimetre or so down below the edges of the tubes. Pieces of caoutchouc tube are used to make the tubes acid-tight, and to make the apparatus firm, a triangular cork wedge is placed within the tubes. Instead of glass cocks, as in the arrangement of Hofmann, pinch-cocks are used, as I found these much more manageable, besides being cheaper. The apparatus, when charged with dilute acid of 1 to 4, will give off about 15 c.c. of gases per minute when four pint cells of Grove's battery are used. (6)

ACTION OF CHARCOAL AND IRON AT RED-HEAT UPON CARBONIC ACID GAS.

By Dr. J. Dumas.—This eminent *savant* communicates the results of a series of experiments made by him, from which the following conclusions may be drawn: When absolutely dry carbonic acid gas is passed over charcoal entirely freed from hydrogen, and heated to cherry-red heat, the gas is converted into oxide of carbon; when there is an excess of charcoal, the whole of the carbonic acid gas is converted into oxide of carbon. The charcoal, even when strongly ignited in closed vessels energetically retains hydrogen or water, which can not be eliminated except by exposing the charcoal for a long time to a current of chlorine gas at red-heat; charcoal not so treated yields, when employed for the conversion of carbonic acid into carbonic oxide, a gas contaminated with traces of hydrogen. When a slow current of dry carbonic acid gas is passed over iron at bright red-heat, a portion of the carbonic acid is converted into oxide of carbon; the bulk of the carbonic acid, however, is left unaltered. (4)

SULPHUR METALS.

E. Priwoznik has made experiments with different kinds of metals, by immersing them into a deep yellow-colored sulphhydrate of ammonium, to which some sulphur had purposely been added; cadmium, lead, bismuth, antimony, zinc, and aluminium, are scarcely acted upon by being kept for several months in a solution of alkaline supersulphurets, care being taken that these metals are quite clean and polished previous to immersion; but, as regards copper, tin, silver, nickel, and iron, the case is different. Perfectly pure copper assumes a dark color on being immersed in the sulphur compound of ammonium, and in a short time it is converted into monosulphuret of copper of a blue color; but when the metal is

kept immersed in the aforesaid solution for a considerable time, the blue color changes to black, and, on analysis, the compound is found to be semi- or sub-sulphuret of copper, Cu_2S. Chemically pure silver becomes, as is generally known, very readily converted into sulphuret by the action of either sulphuretted hydrogen or alkaline sulphurets. When silver is exposed for a longer time to the action of the ammonium solution, the metal is converted into sulphuret of silver, Ag_2S. Tin also forms sulphur compounds under the above conditions, but, owing to the solubility of the sulphur compounds of tin in solutions of alkaline sulphurets, the tin is dissolved; 6·84 per cent of pure Banca tin had been dissolved in eight days. Nickel behaves like tin and iron (bright iron wire 1 m.m. thick), and is slowly and gradually coated with a thin layer of sulphuret. (3)

ACTIVE HYDROGEN.

By M. Chabrier.—The author has discovered that, when hydrogen is electrized by an electric discharge, and not attended with sparks, it then directly combines with nitrogen, forming ammonia. Under the same conditions, hydrogen decomposes freshly-made oxide of silver; and so much heat is evolved by this operation that the globules of metallic silver melt, and in a state of high incandescence take up oxygen, which, on cooling, is given off, producing the well-known phenomenon also observed in the silver assay by the dry way.

FILIFORM NATIVE SILVER.

By Dr. J. H. Gladstone, F.R.S. — Native silver occurs frequently as metallic threads or wires twisted in every direction, and often bent at sharp angles. Specimens of this filiform silver were exhibited (British Association) from Kongsberg, in Norway, associated with calc spar, and from Chili, associated with greenstone, and it was shown that the metal was tough and non-crystalline. Precisely similar threads of silver were produced under the microscope by decomposing a solution of nitrate of silver with suboxide of copper. The white filaments shoot forth in every direction, and twist about or double back in their course; while the cuprous oxide becomes black, splitting up, in fact, into cupric oxide and cupric nitrate. Most of these threads are so fine that their diameter is only $\frac{1}{25000}$th of an inch, and a gramme of such silver wire would stretch from London to Brighton, and many are much finer still. Sometimes these filaments will end in crystalline knobs, or crystals

of silver will form upon them, as is not unfrequently the case in mineralogical specimens. Attempts to prepare them by means of other substances than suboxide of copper had not proved successful; but, as that substance is by no means a rare mineral, it was thought that their formation might result generally from its action on silver salts in solution.

DECOMPOSITION OF WATER.

By J. H. Gladstone, F.R.S., and A. Tribe, F.C.S.—Some metals are able of themselves to displace the hydrogen of pure water, while other metals are unable. Zinc, if perfectly pure, is just incapable of doing so; but, if it be brought into contact with another metal still further removed from the power of effecting the decomposition of water, the electric force started by the contact of the two metals enhances the chemical affinity sufficiently to make it effective; or (otherwise expressed) the chemical force *plus* the electrical increase the tension of water sufficiently to effect its decomposition. The junction of the metals may be made outside the water by a wire; and the amount of action may be determined by a Thomson's galvanometer. The effect of varying the distance of two plates of zinc and copper was tried, and it was found that the chemical action increases slowly till the plates are within about an inch of one another, but on continuing to bring them nearer, the action increases at a rapidly accelerating ratio. If the water be heated when it is exposed to this joint action of chemical and electrical force, it decomposes more readily. In experiments made with two plates, about 1·5 inches distant from one another, the deflection of the galvanometer showed that the effect of raising the temperature from 40° to 80° C. was more than double of that between 20° C. and 40° C.; but in an experiment made when the copper was deposited in a spongy condition on the zinc, and the hydrogen gas produced was collected, the following numbers were obtained:

Mean Temperature.	Duration of Experiment.	Hydrogen collected.	Hydrogen per hour.
2·2° C.	3 hours	3·4 c.c.	1·1 c.c.
22·2° "	2 "	11·1 "	5·5 "
34·4° "	45 mins.	10·4 "	13·9 "
55·0° "	15 "	15·5 "	62·0 "
74·4° "	10 "	29·1 "	174·6 "
93·0° "	5 "	44·0 "	528·0 "

The last column shows the extraordinary acceleration of the action due to heat.

Magnesium is capable by itself of decomposing water,

but its action is greatly increased by touching it with a piece of copper, and some of the hydrogen gas then makes its appearance on the copper plate.

If, instead of magnesium, we take a metal less capable than zinc of decomposing water, we still find a deflection of the galvanometer if it be united with another metal still more negative. The order for pure water seems to be—Platinum, silver, copper, iron, tin, lead, zinc, magnesium.

Experiments were made on the effect of electrical action by using the force generated in one cell of Daniell instead of the force generated by the contact of the metals experimented on. It might be inferred that the electrolysis of water would be more easily effected between the poles made of a metal that has a considerable affinity for oxygen than between poles of a metal which has little affinity. And so it is. When zinc poles were used, there was found to be more than double the action that there was when platinum poles of the same size and at the same distance were employed. The order of efficiency for poles in the electrolysis of water, after about a minute, seems to be—Platinum, tin, silver, copper, iron, lead, zinc, magnesium. After a few minutes, the power of tin was found to rise above that of copper. The other metals are in the same order as in the previous list, where they themselves produced the electricity by their joint action on water.

The effect of heat on the electrolysis of water was tried with two zinc poles. The deflection increased about fourfold between 5° and 80° C., and the action increases nearly *pari passu* with the temperature.

If, instead of employing two poles of the same metal, we use dissimilar metals, we have a current established by these two metals, which, according to its direction, either adds to or subtracts from the current originating in the Daniell's cell. Thus, if two poles of platinum be employed, the effect with water is very minute; but if the negative pole be replaced by one of zinc, pure water is decomposed by one cell of Daniell's battery, with visible evolution of hydrogen gas. The experiment was performed quantitatively with poles of silver and zinc.

Positive.	Negative.	Deflection.
Silver	Silver	27
Zinc	Silver	52
Silver	Zinc	7
Zinc	Zinc	33

When, therefore, the dissimilar metals were employed as poles, the decomposition of the water was not the mean of that producible by silver and by zinc, viz., 30, but 30+22 when the two forces acted in the same direction, and 30—23 when they acted against one another. (6)

A NEW METHOD OF OBTAINING POTASSIUM.

By Prof. A. E. Dolbear.—Some white stick caustic potash of commerce was dissolved in water and then treated with sulphuretted hydrogen in the way commonly described for making potassium sulphide, K_2S. The solution was evaporated until it was solid when cool, when the yellowish mass was mixed with more than its bulk of iron filings and chips, and the whole put into an alembic for distillation. The heat of a furnace was applied till the alembic was of a bright red-heat, and the products of distillation were received in common coal oil. The product was rather small, as some of the potassium vapor decomposed the heated vessel; nevertheless the potassium showed itself when the oil was poured off, and the residuum turned upon water, by its characteristic ignition and flame. The reaction is simple and may be thus represented: $K_2S+Fe=FeS+K_2$.

The materials used for thus obtaining it are of the required cheapness, and the iron sulphide product can again be used to furnish sulphuretted hydrogen for another quantity.

It is probable that sodium can be obtained by an analogous process, but I have not attempted it.

PHOSPHORIC ACID FROM IRON ORES.

By Julius Jacobi, *Director of the Smelting Works at Kladno, Bohemia.*—The method of working proposed by the inventor consists in changing the insoluble basic phosphates contained in the ores into soluble acid phosphates, and the separation of the soluble phosphates, by a simple process of leaching.

In order to attain this result, the ore is treated with a compound of sulphur and oxygen usually most advantageously and cheaply with sulphurous acid in the gaseous state or in solution, for which purpose a very dense ore must naturally be pulverized, a pyritous ore or one containing carbonic acid must be well roasted by well-known methods, while a porous ore which allows the penetration of the liquid into the pores, can be used in pieces of moderate size. The ore thus prepared is placed in receivers the size and shape of which must be dependent on various conditions, and water impregnated with sulphurous acid is turned upon it, or the sulphurous acid gas is conducted at once to the ore, while a stream of cold water is turned upon it at the same time, so that the absorption of the sulphurous acid into the ore takes place through the medium of the water.

The solution is then drawn off and replaced by water, which will remove the salts rendered soluble but not previously removed. This washing is continued as long as phosphoric acid may be detected in the wash water. If phosphoric acid still remains in the ores, the same process may be gone through with once or several times more, according to the degree of purity required for the ore. It is evident that the duration of the operation must be regulated by the amount of phosphate in the ore, and its porosity. After the last treatment with acid, the ore must be well washed with water, to remove all traces of the acid.

The water remaining after each treatment, which contains the phosphorus compounds, is collected and heated directly by a naked fire, or by passing steam pipes through it, in order to drive off the sulphurous acid, by which means a portion of the phosphates will be precipitated. The sulphurous acid thus driven off may be allowed to escape into the air, or if one is economically inclined it may be again united with water and used over again. The liquid, in which by heating a portion of the phosphorus compounds have already been precipitated, is then treated with burnt lime, and allowed to stand until the whole precipitate, which contains all the precipitable substances, has settled to the bottom of the tank. The addition of lime is of course only necessary when, by heating the liquid to drive off the sulphurous acid, all the phosphorus compounds are not precipitated, which is the case with many ores. Thereupon the clear liquid is to be drawn off, and the deposit, when it has attained the right consistency, removed. This is now, on account of its containing phosphoric acid, a very valuable product for agriculture and the arts, and may be sold for direct application in agriculture, or for further working up. In many cases the proceeds from this sale will cover a large part of the expense of treatment. The preparation of the sulphurous acid is effected by some known method from sulphur, pyrites (where these are to be obtained cheaply), or from other similar substances.

By the removal of the phosphorus compounds the iron ore becomes somewhat richer in iron, as well as purer.

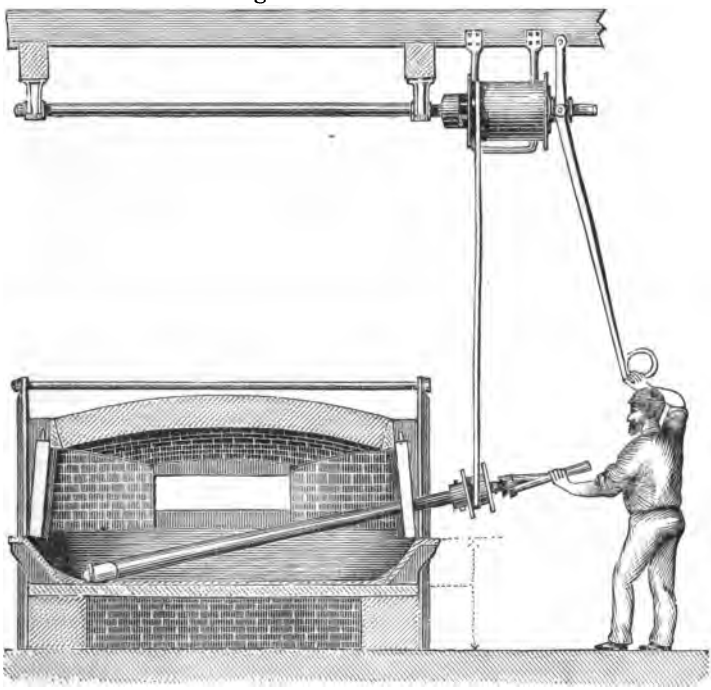
ARTIFICIAL FORMATION OF CAMPHOR.

By A. Oppenheim.—While oxidizing terpen-cymol, the author obtained a small quantity of a solid body which, on being analyzed, proved to be camphor, which has thus been synthetically formed.

DORMOY'S PUDDLING RABBLE.

AMONG the recent improvements intended to facilitate the production of puddled iron, and save workmen from the severe labors that have heretofore attended the working of this industry, is Dormoy's rotary puddler, which is now being extensively employed in England and on the continent.

The engraving shows a section through the puddling door, with a rotating rabble, held at one end by the puddler, inserted through it.



DORMOY'S PUDDLING SHAFT.

A few feet above the furnace there is carried a shaft fitted with a drum; it turns loosely on the shaft, except when caught by a simple clutch, and its extra width is for the purpose of allowing any slight sliding to and fro of the belt. A common pair of fast-and-loose pulleys would not answer. The centre of this drum is about a foot from the

door of the puddling furnace, and as its belt can be crossed, the longitudinal axis of the drum can be set to any angle whatever with the furnace. The belt it drives is about 2 in. wide, and it carries a sheave about 6 in. in diameter, and fitted with rather high rims. One end of this sheave turns loosely on a pin screwed into a handle of the rabble, leaving it quiescent in the hands of the puddler. The rather long boss cast on the other end of the sheave is cored out, and the outer end of the rabble itself, being forged with a boss, is loosely pinned inside it, in such wise as to allow a little play. The end of the rabble that dips into the bath of molten metal is either fitted with a disk or is somewhat increased in diameter. The whole tool weighs from 80 lbs. to 120 lbs., this weight being partly carried by the strap and partly by the bed of the furnace. It is rotated at speeds varying from 300 to 800 revolutions per minute for white pig and from 800 to 1000 for gray pig-iron. The muscular power of the puddler is scarcely called upon, the work of carrying the tool and stirring up the metal being transferred to the belt and thence to the engine. An inferior, a weaker, or an aged man can thus turn out well-puddled iron.

It will be observed that a duplex action results in this simple mode. The puddler can direct the rabble to any portion of the iron, when, rotating at a high speed, it energetically stirs it up like an egg-beater. When the iron is come to nature—differing in this from any other mechanical rabble—the tool is still worked, insinuating itself through the stiff pasty mass like a drill. The balling operation is thus partly completed, it can be entirely completed by this tool if the mass has not to be divided for piling; while the ball can be at once hammered as usual.

The hearth is preferably fitted with a conical basin, tapering upward, in order to somewhat diminish the area of the working surface. The power required is at from one quarter to one half a horse-power per furnace. The strap, if kept well greased, has been found to last from three to four months without renewal. Only one tool is used per heat with white pig; from two to three with gray.

With a double furnace, which can be charged with one ton of pig-iron, if the pig be kept supplied from a cupola to save time in melting, not less than one charge of one ton can be put out per hour, as has been proved by experience in Austria. There can be little doubt that charges of from three to four tons could be puddled with the rotating rabble. With this more rapid production there is less wear and tear per ton produced than in the ordinary furnace. The proportion of loss to yield is the

same, but the great command of puddling power enables the yield to be proportionately increased with the amount and purity of the fettling used, more especially with pure hematite and other mineral fettling. (61)

PUDDLING FURNACE AND HEAT-RESTORER.

A ROTARY gas-heated puddling furnace has been combined by William Sellers with a heat-restoring apparatus consisting of a series of tubes through which the waste heat passes, arranged in a similar manner to those in the furnace of Gorman & Paton, before referred to, but differing in being divided into two sets—one of which heats gas and the other air—so arranged that the gas and air after being heated meet in opposing columns so as to be thoroughly mixed before combustion, at the mouth of the rotary furnace, where the mixture becomes ignited and passing through the furnace acts on the metal therein, and then enters the regenerating tubes, leaving there the most of the waste heat to be again taken up by the incoming air and gas. To remedy a difficulty experienced in starting this class of furnace, owing to the cold air contained in the passages, a flue is provided in which fire may be introduced to heat the air and so induce a current.

PUDDLING FURNACE.

MESSRS. WOOD & JACKSON have invented an oscillating or rotary puddling furnace of cylindrical form, having two skins, between which is a water-space for protecting the sides of the cylinder from heat, and on its inner upper surface a lining of brick, to reduce the amount of space, and so prevent the loss of heat. At each end is a trunnion on which the cylinder turns, and through which the flame from the furnace makes its entrance and exit. These trunnions are also protected by water-chambers. On the top and through the brick lining is an opening through which the iron is fed to be heated, and through which it is removed when balled, the cylinder being partially rotated for this purpose. Beneath the water-space is located an air-chamber, from which a set of tuyeres open into the cylinder, and through them a steady blast is forced through the molten iron, which, combined with an oscillating motion of the cylinder, it is said, produces a superior quality of iron.

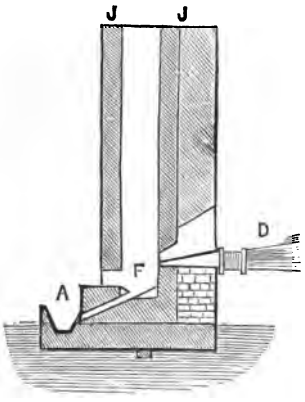
REVERBERATORY FURNACES.—The necks of reverberatory furnaces are frequently burnt out by the intense heat, and to counteract this, Hamilton & McDonald propose to insert a perforated pipe in the neck through which jets of steam are constantly issuing, whereby the heat is modified at this point.

TIN-MINING IN BANCA.

TIN appears only either as a sulphide or as a bin-oxide, (cassiterite.) Tin as a sulphide is very rare, but as a bin-oxide it occurs quite frequently, and is found in Chili, Mexico, Brazil, England, Bohemia, Saxony, Spain, Burmah, Malacca, and California, but especially in Banca and Billiton. It appears in Banca, Malay Islands, as stream tin (black, and sometimes light brown) and as vein tin. At present the Dutch Government only works the stream tin in Banca, which is deposited in the valleys in enormous quantities. The beds are from 9 to 30 feet deep, and consist of mud, red clay, blue clay, coarse and fine gravel, and tin. The tin beds are generally from 3 in. to 22 in. deep, but in some localities still deeper. Kaolin (porcelain-earth) appears below the fine gravel, and there is no hope of finding tin below that. To examine the mineral capacity of the valleys, cuts are run across them at about 100 yards apart; 3-in. holes are bored in these cuts from 20 to 25 yards apart; a copper pipe is let in, to prevent the sides of the holes from falling in, and an exact quantity of tin ore taken from each hole. The tin extracted from all these different holes is carefully washed and weighed, and a calculation is made as to the probable richness of the valley. Mines are then laid out to be worked during the hot season, which continues eight months. The remaining four months of the year, which form the rainy season, are occupied in smelting.

All of the mines are worked under the superintendence of European mining engineers and foremen, with companies of from 60 to 300 men. Work on these surface mines is begun from the lower end of the valley. Before commencing operations a dam is made across the valley, and the water drained off by means of ditches, which are used in the process of washing. The water from the mines is removed by means of chain-pumps. The gravel from the new mines is disposed of by being thrown back into the old holes.

The treatment of the tin (cassiterite) is very simple. After being washed out, the mineral is taken to be roasted in a reverberatory furnace, for the purpose of getting rid of the arsenic and separating the sulphides of iron and copper. The roasted masses are then placed in large tubs of water, where the sulphides of iron and copper dissolve, and the oxides of tin, iron, and copper settle down. The separation of the sulphate is performed by evaporation and crystallization. The oxides are exposed for several days to the air, and afterward worked. Then the oxides



are mixed up with charcoal and put in a blast-furnace, like those shown in the accompanying cut. This is a vertical cylinder of cast iron, 9 feet high, covered with clay J, J, into which air is blown by means of bellows through the pipe D. In the bottom part F the coal oxide is gathered together, and attacks the oxide of tin, so that the liquid tin runs with the slag into a trough A outside the furnace. From time to time the floating slags are taken off, and when the trough is full the vent is opened, and the metal runs in a second trough. In this trough the remaining foreign substances are taken off. This is done by taking pieces of wet greenwood, putting them on an iron rod, and dipping them in the melted mass. The charring of this greenwood produces steam, and causes the foreign substances to float, so that they are readily taken off. By this method the tin produced in Banca is the best in the market. It is soft, pliable, easily stretched, very clear and of a shining bluish-white color, and easily smelted. (54)

ELECTRICAL METALLURGY.

It is stated by A. T. Hay that by using an electric coil or helix around a furnace, so that ore melted therein will form the core, the magnetism generated will promote the reduction, fusion, and carbonization of the ore thus acted on, and produce grades of carburet of iron heretofore unknown, that are valuable in the production of wrought-iron and steel, and metallic products that are free from the usual impurities contained in the iron or imparted from the coal. By melting one part of pig or scrap with five parts of Iron Mountain ore, under the influence of the coil, a heavy, bright carburet is produced, and by reducing Shepherd Mount, Iron Mount, or Pilot Knob ore, with a small percentage of limestone, a dark, brittle, magnetic carburet is formed, which may be remelted at a heat below the welding-point of iron. These products may be utilized, by immersing iron in a bath composed of one part of the heavy bright carburet, with three parts of the dark, brittle carburet, and a small percentage of oxide of

iron, melted together in a crucible. Iron so treated will be converted into steel on its surface. When exposed to the blast, in an open hearth, under a coal-fire, these carburets intensify the heat and impart steel qualities to iron heated therein. By immersing iron in a molten bath of the dark carburet a coating of apparently pure white iron is given to it, which renders it less oxidizable.

MANUFACTURING STEEL.

A FURNACE for the above purpose has been devised by Ira Hersey, in which the "balls" from a bloomery are transferred to an inclined hearth-floor in which the proper chemicals for carburizing—manganese, prussiate of potash, charcoal, and salt—are introduced in thin sheet-iron cans. The metal as fast as melted combines with the chemicals and runs into a receiving basin at the bottom, from whence the steel so formed may be drawn to form ingots. By the use of the basin a large quantity of the melted metal may be retained surrounded by heat until the amount required for the casting is melted.

TEMPERING STEEL.

BY a process discovered by A. H. Siegfried, steel may be refined and tempered by heating it to a cherry-red in a fire purified by throwing in salt, then covering the steel with the same substance, and while subjecting it to this treatment, working it nearly to the finished form. A compound of the following ingredients is then substituted for the salt: one part of each of salt, sulphate of copper, sal ammonia, and sal soda, and a half part of nitrate of potash; and the steel is alternately heated and treated with this until it is refined and brought to the finished form. It is then slowly heated to a cherry-red, and plunged into a bath of the following ingredients: alum, sal soda, and sulphate of copper, of each one and a half ounces; nitrate of potassa, one ounce; and salt, six ounces; dissolved in a gallon of rain-water.

AMALGAMS.

DURING some recent experiments on amalgams, made with dry filings and mercury, with the object of obtaining one free from shrinkage, I find a law which apparently holds good in all cases, namely, that any alloy which when reduced to filings will harden, when mixed with mercury, without shrinkage, is also free from shrinkage when cast. An alloy containing gold, platinum, silver, and tin, if poured at a clear red-heat into a warm iron mould, remains perfectly rigid, and can not be removed from the mould

without considerable force. If this alloy, in filings, is mixed with about 15 to 17 per cent of mercury, and pressed into a solid mass into a mould, it remains tight in its place, without shrinkage, after it has become as hard as good brass, and continued heavy pressure will not force a trace of a colored solution between the mould and the plug of amalgam. Whether this law holds good with every alloy, I can not say, but it evidently does so with a great many of similar composition to the one mentioned.—THOMAS FLETCHER, F.C.S.

PLATING METALS.

A NEW method of plating has been suggested by E. E. De Lobstein, who first subjects the article to be plated to the action of a battery in a cold solution of the required metal, and afterward heats the plated article until the coating is melted. By depositing two metals in this manner, the superimposed metals are melted, and alloys may thus be formed on the surface of a baser metal.

STEEL CASTINGS.

THE leading steel-makers in England and on the continent can now turn out steel castings, the production of which would have been deemed utterly impossible not many years ago. At present the excessively high temperature at which it is necessary to run the steel, and consequently the great shrinkage which takes place during cooling, is a difficulty in the way of producing castings of complex form, or having parts of very limited thickness, while the greater or less porosity of many of the castings renders them inapplicable in numerous instances where their great strength would otherwise render them especially valuable.

There appears here to be an indication that what is wanted is an alloy of steel, which should retain the strength of the latter while having a lower melting-point and increased fluidity. That such an alloy, or its equivalent, will ultimately be discovered, we see, says *Engineering*, no reasonable reason for doubting. And here we may say that we use the word "alloy" in its broadest sense, as meaning not merely a mixture of one metal with another, but a mixture of a metal with any element, metallic or otherwise. The whole subject of alloys is one of vast importance, and one which has never yet received the full attention it deserves. We in fact know of no more promising field of research than that which the investigation of alloys offers, and we trust that no great time may elapse before it is more thoroughly cultivated.

PHOSPHOR-BRONZE.

AN important instance of the effect exercised on the properties of a metal by the admixture of a very small percentage of a foreign substance is afforded by the "phosphor-bronze" of MM. Montefiore-Levi and G. Kunzel, From particulars of careful experiments with this material, it appears that the addition of a very small percentage of phosphorus to gun-metal containing 10 per cent of tin, increased the elastic limit about 35 per cent, and the breaking strain per square inch of the original section 80 per cent; while one sample of phosphor-bronze, containing 6.2 per cent of tin, had a breaking strain of over 51,000 lbs. per square inch of original section, and elongated 10 per cent before fracture. Phosphor-bronze appears to be capable of making very close and dense castings, while the property it possesses of casting well in metal moulds is one of very great value in a number of instances.

WELDING COPPER.

A NEW process of welding copper has been devised by Messrs. Schurr & Rehbein, which they claim entirely overcomes the difficulty heretofore experienced in this operation. They first prepare the joints to be welded by placing borax between the surfaces, which are then hammered together while hot. The joint is then brought to a white heat, powdered over quickly with chloride of magnesia or chloride of sodium, and then welded. The weld can also be made by directing a stream of chlorine gas upon the heated copper during the process of welding.

SEPARATING FLOAT GOLD.

MUCH gold is lost in mining operations from the difficulty of separating what is known as "float" or "flour" gold from the water used in washing the ore, and E. J. Frazer suggests that the water be filtered through sponge, or some equivalent material, having its pores filled with mercury. To recover the gold taken up by this process, the filtering medium should then be destroyed either by fire or by acid.

TREATING SLAG.

SLAG in its raw state is very difficult to reduce, owing to an excess of silicic acid, its density, and the sulphur and phosphorus combined with it. To overcome this, J. M. Hartman mixes with it, while in a molten state, seven parts of limestone, two parts of alumina, and ten parts of coal or carbon, to every five parts of silica in the slag, and sufficient black oxide of manganese to discharge the sul-

phur and phosphorus. If the black oxide of manganese is not to be had, manganese, fluorine, and potash may be substituted. By this process the slag is thoroughly honeycombed so as to be easily acted on by carbonic oxide when in the blast-furnace. Slag may also be made porous by forcing water or air through it, but neither will neutralize the acid nor discharge the sulphur and phosphorus.

MALLEABLE CASTINGS.

A NEW process for making castings malleable, proposed by A. F. Andrews, consists in packing the cast articles with lime, marble-dust, finely divided clay, peroxide of iron or silicate of aluminum, in cases of clay having perforated false bottoms. These cases are placed side by side in a suitable furnace, and heated from six to ten hours, during which time a current of hydrogen is forced through the perforation in the false bottom, either pure or mixed with carbonic oxide, or these gases may be used alternately. The cases are then removed to a cooling-pit, and the furnace is ready for another set of cases.

ALLOY RESEMBLING SILVER.

A NEW alloy, said to resemble silver, devised by Helen L. Macker, consists of five pounds of tin, four ounces of antimony, a half ounce of aluminum, a half ounce of mercury, and two ounces of bismuth. If a still cheaper metal is desired, one pound of lead should be added. If the metal is to be rolled, the bismuth should be left out, and two ounces of copper added, and if a very stiff metal is required, more copper should be used.

The same lady proposes, as another substitute for silver, an amalgam of three pounds of zinc, one ounce of quicksilver, one quarter-pound of white shellac, and the same of white resin, mixed together by melting. By adding one pound of nickel, it may be made much harder. This is said to be a very superior article for harness-fittings, etc.

CONVERTING IRON INTO STEEL.

IN converting iron into steel by means of hydro-carbon vapors, the materials have usually been operated on in a retort having an opening, furnace, and hydro-carbon jet-pipe at one end only, which has been found inconvenient on account of the irregularity of its action, and T. R. Scowden suggests that this may be remedied by supplying such retort with an opening, a furnace, and jet-pipes at each end, whereby the heat and supply of carbon may be readily controlled, and opportunity given for examination at both ends of the retort.

HENDERSON'S IRON PROCESSES.

DURING the past twelve months, considerable interest has attached to a new process introduced into the iron manufacture, especially in Great Britain, by Mr. James Henderson, of New-York, showing very remarkable results.

These inventions enable makers to produce high qualities of cast-iron, steel and wrought-iron, from inferior descriptions of pig-iron. Cinder-pig and other irons, highly charged with phosphorus, sulphur, and silicon, are thereby freed from these impurities, and it is the distinguishing feature of these processes that the carbon is not removed in a corresponding degree.

The principle of Henderson's processes consists in the use of fluorine, in conjunction with oxygen, which, acting on the molten cast-iron, in a few minutes almost completely purifies it. In applying them to the manufacture of wrought-iron, the mode of working which has hitherto given the best results is as follows: Fluorspar and oxides of iron (titanic iron ore) are ground to a fine powder, mixed thoroughly, and thrown into the ordinary puddling furnace; the molten cast-iron to be acted on is then poured over the spar and oxides, which remain on the bottom of the furnace. The furnace-door is closed, and the iron allowed to boil for about half an hour; the rabble is then worked for about ten minutes, and the metal is balled up in the usual way. The whole time occupied by one charge, with ordinary grey-forge pig-iron, being a little under one hour.

The mode in which the purification of the iron is effected appears to be as follows: After the cast-iron has been poured in, and the furnace-door shut, the heat of the metal melts the fluorspar and oxides, which, combining with the silicon, sulphur and phosphorus, and part of the carbon, removes them from the cast-iron in the form of vapor and slag, and this so effectually that, by the time ordinary grey-iron has had the amount of carbon in it reduced to 2½ per cent, common brands of pig-iron are rendered as free from impurity as good "Bessemer steel."

If the cast-iron is boiled, for from three quarters of an hour to an hour, over the fluorspar and oxides, the carbon is nearly all removed, pure malleable iron being deposited all over the bed of the furnace, from whence it can be removed and hammered and worked in the usual manner. Although this is interesting as a chemical experiment, the manufacture of wrought-iron by this method without puddling can not be recommended where ordinary puddling furnaces are in use, as it is tedious, and there is sometimes

considerable difficulty in removing the iron from the bottom of the furnace after it has settled down there. It is found also, that continuing the process for so long a time is not required for purifying the cast-iron, as the fluorine and oxygen remove the phosphorus and other impurities within a few minutes after the commencement of the chemical reactions.

It will be seen that the exhausting manual labor usually required to bring cast-iron to nature in puddling is thus to a large extent dispensed with, even in the ordinary puddling furnace, while the rapid removal of the impurities from the iron which takes place at the commencement of the chemical reactions, admits of a great variety of modifications, whether it be applied to the manufacture of steel direct from cast-iron, or simply to purifying the cast-iron; in the one case, steel is produced just before the carbon is completely removed, and in the other, pure cast-iron can be obtained, which can be used for making Bessemer or other steel, or for purposes for which very pure cast-iron is required. The loss in converting cast-iron into wrought-iron by these processes is about ten per cent.

The removal of impurities by the Henderson processes enables iron of a very high quality indeed to be made from cinder-pig and other common brands of cast-iron, as evidenced by the tests and analyses. Although the tensile strength of the iron is very great, it is chiefly remarkable for its toughness, as will be seen from the high elongation. Great elongation is one of the most valuable and peculiar properties of the iron made by the Henderson processes. For instance, plates made in England, at Bowling Iron Works, Bradford, from Yorkshire cinder-pig iron, gave more than double the elongation of Lowmoor, Bowling, and Farnley.

The tests were made by Mr. Kirkaldy, and the following is a summary of them. Bowling, Lowmoor, and Farnley plates, made by their usual processes, also tested by Mr. Kirkaldy, are given for comparison:

	Ultimate tensile strength, tons.	Contraction of area per cent.	Elongation per cent.
Henderson's cinder boiler plate Mean of length and crossway.	24.73	32.4	23.7
Bowling, Lowmoor, and Farnley Mean of length and crossway.	23.60	16.6	11.27
	1.13	15.8	12.43
Difference in favor of Henderson's cinder iron, tensile strength	4.78 per cent.		
Difference in favor of Henderson's cinder iron, contraction of area	100 do.		
Difference in favor of Henderson's cinder iron, elongation	110 do.		

The test shows a contraction of area double that required by Government Classification for the highest quality of plate-iron.

Toughness is a matter to which engineers are beginning to attach great importance, as iron which has great elongation is much more trustworthy than "short iron," although the latter may maintain as high a breaking strain as the former.

The best proof of the completeness of the purification of the iron was shown by the fact that steel manufactured from wrought-iron, made by these processes from common Scotch pig-iron, gave a tensile strength equal to steel made from the best Swedish irons; when made into tools, it also stood wear equally well.

An analysis by Dr. H. M. Noad shows by these processes every impurity was removed from the iron.

A characteristic feature of one mode of working is that the greater part of the phosphorus is eliminated from the iron, in the condition of vapor passing up the chimney of the furnace: thus, a purer quality of cast-iron can be produced from this cinder than from the cinder of the ordinary puddling furnace. By the Henderson processes, iron in England can be made equal in purity to the best Swedish, and substituted for Swedish in making the highest classes of steel.

All the tests of the finished iron and steel were made and certified by D. Kirkaldy, Esq., of the Grove, Southwark street, London, S. E., for the elastic and ultimate tensile strength, etc.

Mr. Henry Aitken, of Falkirk, is, we understand, associated with Mr. Henderson in the development and working of these patent processes in the United Kingdom. (74)

QUICKLIME IN THE BLAST-FURNACE.

By J. Gruner.—The author shows that in order to effect the greatest economy in fuel in the blast-furnace operations, instead of using raw limestone, raw iron ore, etc.:—

1st. The limestone should be well calcined, (*i. e.*, converted into quicklime,) and it is recommended that this be done separately in a Hofmann's circular furnace, in which the calcining may be performed most economically as regards fuel.

2d. The raw iron ores should be also well dried, and freed from carbonic acid by roasting separately.

3d. The fuel should be perfectly dry.

By carefully observing the above directions, at least 100 lbs. of coke per ton of pig-iron may be saved.

IRON AND STEEL AMALGAMS.

I HAVE now to claim as a discovery the direct amalgamation of *steel*, even when of the toughest and hardest character. The blade of the best penknife is readily amalgamated, and suffers from the contact, while a plate of fine sheet-steel, used in the manufacture of superior instruments, is easily coated with mercury and made to resemble a sheet of silver. By magnetizing soft steel, reducing a sufficient amount of it to filings, and dissolving the filings in mercury, I have procured a magnetic amalgam, in the presence of which an astatic needle is decidedly bewildered. A horseshoe magnet, brightly coated with and upholding an inverted arch of fluid, dripping mercury, lifts quicksilver, it is true, but quicksilver loaded with an amalgam of magnetized steel; an attraction much stronger than that evinced for iron amalgam.

A glass tube properly charged with the magnetic amalgam exhibits the polarity of the compass-needle, and has its extremities attracted and repelled by the poles of the magnet in the same manner that the poles of the compass-needle are attracted and repelled. This property of the magnetic amalgam is interesting, as it proves that, however minutely divided, the atoms of steel still retain their magnetism, and are still influenced by the directive currents of the earth. I have not yet been able to make a very powerful needle of this kind; but, though my observations are very imperfect, I am able to say that it seems to point a little more truly to the magnetic north, and from its greater inertia to be less subject to irregular changes of variation than the ordinary compass-needle. The inertia is to be attributed to the assumption by the magnetized steel of a certain portion of the weight or specific gravity of the mercury. When this amalgam is exposed to the oxidizing influence of the atmosphere, it is gradually decomposed, carbon being liberated, and the permanent magnetism vanishing, while iron amalgam remains. This will also finally decompose, pure mercury and ferrous oxide resulting.

Another discovery that I may claim, is the direct amalgamation of *cast-iron*, even of the most brittle and highly carbureted character. This was first effected by means of a compound amalgam of potassium, sodium, and "ammonium" with water; but I have since found that a simple amalgam of potassium or sodium is generally sufficient to effect the result. The surface of cast-iron may be amalgamated by placing an electro-positive or active amalgam upon it with water or an acid; a true amalgam may be similarly formed with filings.

In the course of the experiments which led to this discovery, it was my fortune to observe phenomena of an extraordinary character. The usual brilliant surface of mercury is produced when cast-iron is treated with the electro-positive amalgam, and the iron is rapidly "cut" or dissolved. The impurities of the iron, with considerable carbon, are released and form a black mud around the button of amalgam. If at this moment, before all the positive metal has been oxidized, the amalgam be removed, washed, and allowed to stand, particles of amorphous carbon will be seen to emerge and float upon its mirror-like surface. Whence comes this carbon; why was it not given up before? Has it been amalgamated; and if so, has it not a metallic character? It has been suggested to me that particles of undissolved iron, containing carbon, have been carried bodily into the amalgam, and afterward dissolved, releasing their carbon. However, this is but a conjecture; the reaction certainly deserves study.

The mere intimation that carbon, the great protean thing in nature, may, after all, have a metallic origin, is very interesting. Those who believe in the ammonium of Berzelius or the hydrogenium of Graham, need not fear to examine the claims of carbon to a metallic parentage, nor does the existence of such a metal seem so improbable when we remember the electric conductibility of two of the allotropic forms of carbon, gas-coke and plumbago; the first already replacing, in the voltaic batteries of the present day, the electro-negative elements, platinum, copper, etc., while the latter replaces similar electro-negative elements when brushed, in the form of plumbago powder, upon the surface of the mould or plaster-cast which the electroplater desires to coat with copper or other metal.

If metallic carbonium exists, it may be assumed to be an electro-negative metal. It is true that some forms of carbon are highly inflammable, but are they more so than Graham's hydrogenium? Graphite at ordinary temperatures is far from combustible, and when it burns, or when the diamond burns in oxygen gas, wrought-iron will burn also. No one doubts that iron is a metal, yet one of its purest forms is pyrophoric, taking fire and burning on contact with the atmosphere. To associate graphite with sulphur and phosphorus is to place it, a good conductor of electricity, side by side with the very enemies of traveling magnetism. For how many ages was molybdenite undistinguished from graphite, and who is there now that can instantly distinguish the one

from the other? It is true that molybdenite is a sulphide of molybdenum, and graphite a pure allotropic form of carbon, but may there not be one more form of carbon? There is no substance in nature more readily recognized as a metal by the unlearned than graphite; to this day it is impossible to take from it the improper title of black-lead. The experiments of Sir Benjamin Brodie with graphite, his discovery of graphic acid and its combination with ammonia, (*graphate of ammonia?*) afford another analogy; for molybdenum has its molybdic acid, and what chemist is there that is not familiar with *molybdate of ammonia?* I have found that contact of native graphite with an electro-positive amalgam and water or acid, produces the same reaction and effervescence as when a negative metal occupied the place, but an amalgam did not seem to form.—V. COLVIN.

WOLFRAM STEEL.

MR. MUSHET'S so-called special steel, which is remarkable for its hardness and strength, was analyzed by Heeren, of Hanover, and found to be nothing but wolfram steel, containing 8.3 per cent wolfram, and 1.73 per cent manganese. The Clyde Steel and Iron Works, of Sheffield, are said to produce much of this kind of wolfram steel as well as the steel works of Rob Oxland, at Gifford, near Plymouth, and of Wund & Co., at Buckau, near Magdeburg, in Prussia, and quite recently it is made also by the works at Uslar-on-Solling, in Hanover. The qualities of this kind of special wolfram steel are very remarkable. When annealed it is so hard that it will stand the best file, but when chilled it becomes soft, when ordinary steel would be hardened. When chilled it gets covered with cracks, but it may be very well hammered when at a red heat. But any tools must be made at once with the hammer in their intended shape, as the file will do nothing more to it. At the engine-works of Messrs. Knoevenagel, at Hanover, tools of wolfram steel are much used, and with planing machines, for instance, will stand infinitely longer than if made of the best Sheffield cast-steel.

ALLOYS OF COPPER AND ZINC.

THESE two metals will mix with each other in all proportions. The color of the alloy varies with the proportion of zinc present, from almost copper-red to zinc-white. The alloys are made by mixing granulated copper and zinc in proper amounts, placing the mixture in black-lead or Hessian crucibles, and putting these in a suitable furnace. The alloy must be removed as soon as melted, since by exposure to a high temperature it loses zinc.

Several of these alloys have received distinctive names. Pinchbeck contains 6 or 7 parts of zinc to 94 or 93 parts of copper. It has a reddish color, resembling red gold, and was formerly much used for watches and jewelry. When pale gold became fashionable, the alloy was also changed and it was called oroide; this consists of 10 parts of zinc to 90 of copper. Another alloy which is frequently used as a base for gilded articles is called tombac, and contains from 20 to 30 parts of zinc, and 70 to 80 of copper. Dutch gold, which is used for imitation of gilding, is composed of 14 parts of zinc and 86 of copper. This is malleable, and can be hammered into very thin sheets.

Brass contains 33.3 parts of zinc, to 66.7 parts of copper, varying, however, somewhat from those proportions according to the use that is to be made of it. It has several advantages over pure copper, besides being cheaper. It is much easier to work in the lathe, being harder and not so tough. It will also make perfect castings, which are hard to obtain from pure copper. A little lead is frequently added to brass, as it is not so tough and does not clog the file when containing about one per cent of this metal. Prince metal and mosaic gold are of the same composition as brass.

Ormolu contains equal parts of copper and zinc. Muntz or yellow metal differs from other brass in that it may be rolled when hot; it contains 40 parts of zinc to sixty of copper. The ordinary hard solder for brass may be made by melting two parts of brass with one of zinc.

Sterro metal contains, besides copper and zinc, a little tin and iron; it is very hard, and has been proposed as a substitute for yellow metal in sheathing ships. Mallet's brass, which is used for protecting iron from oxidation, contains 25.4 parts of copper to 74.6 of zinc.

DANKS'S PUDDLING-FURNACE.

By P. Tunner.—By the rotary puddling-furnace there is not only a quicker, more complete, and cheaper puddling effected than in the hand-worked furnace, but a more complete separation of the phosphorus is brought about. The more complete separation of the phosphorus depends upon the fact that pure rich iron ores are used for fettling the furnace. To every 600 pounds of pig, 650 to 670 pounds of puddled iron are added, and 80 to 100 pounds of iron at least are reduced from the ore which forms the furnace-lining. According to Danks's statement, about 50 per cent of the iron contained in these pure fettling ores should be obtained. From the above it follows that for every charge made, about 100 pounds of iron from the ores is car-

ried away in the slag, and since the ores contain, or should contain, but little silica, and the pig can contribute but a small quantity, this slag is very basic and rich in iron. Its composition is undoubtedly much altered by the many further additions of squeezer and puddle-slag; but the furnace-lining, with which the iron during every agitation is being brought into contact, continually offers a prevailing oxidizing surface of ferric oxide. The separated phosphorus can pass into the slag only as phosphoric acid, reducing a portion of ferric oxide, and combining with another portion of ferrous oxide. It has long been known that the passing of the phosphorus into the slags occurs only in the case of those very rich in iron. In any other form of the process it would be difficult, or at all events too costly, to use oxide of iron in such quantity and of such a degree of purity to separate the silica and phosphorus, as is done in the case of Danks's puddling-furnace lining. As it is, these impurities may indeed be looked upon as useful, since they contribute to the increased yield of puddled iron.

INFLUENCE OF MAGNETISM ON STEEL.

EXPERIMENTS have been recently made by M. Tréve, an officer in the French Marine, and by M. Chédeville, Directeur du Génie Maritime, at Brest, with a view to ascertain if the action of magnetism upon steel changes its structure and reduces its resistance. We extract from a note presented by M. Tréve to the Academy of Sciences, the following remarks: Two cylindrical moulds, exactly similar, were filled with cast-steel. One of these moulds was surrounded with a coil, made by M. Ruhmkorff, through which was passed a current from a 12-element Bunsen battery, during the whole time that the metal was cooling. The other casting was allowed to cool gradually, in the ordinary manner. At the end of ten hours the moulds were broken; the two steel cylinders were removed, and were broken into several pieces, in order that their structure might be examined.

It was stated that the grain of the metal presented different appearances in the two cylinders. In that one submitted to magnetic action, during the time of cooling down—a period when the molecules could most easily arrange themselves—the grain was visibly finer. This experiment, repeated three times, resulted in precisely similar effects. M. Chédeville afterwards made some comparative experiments on the resisting power to extension and compression, and found that the magnetized steel offered less resistance in every case than the other. (28)

DEPHOSPHORIZING IRON ORE.

METALLURGISTS have for a long time past made great efforts to utilize iron ores which are contaminated by phosphorus, and which in consequence yield an iron of inferior quality, being almost invariably cold-short. The quantity of iron ore so contaminated is enormous in many of the more recent geological formations, such as the oolitic, cretaceous, and tertiary formations, where the ore is either found in the shape of a carbonate or a hydrate of iron, always intimately contaminated by phosphate of lime. Of this character are the heavy beds of iron ore in the Middlesbrough district, in Luxembourg, Lothringen, Bavaria, Hanover, Bohemia, and many other localities. It was the phosphorus which forbade the use of a number of these ores for many years, until modern metallurgists had learnt, by using larger furnaces and more limestone, and by adopting a judicious admixture of other ores, to extract a cheap and tolerable iron from them. Nevertheless it has always been a desideratum to neutralize the injurious influence of the phosphorus in one way or the other. Some engineers have endeavored to extract the phosphorus from the ore wherein it is contained in the shape of basic phosphate of lime, which is insoluble in water, and the object of all their exertions being to render this compound soluble by converting it into acid phosphate of lime by the action of other mineral acids which would combine with a part of the lime, and set an equivalent of phosphoric acid free to combine with the rest of the phosphate of lime, thus forming a superphosphate. This idea is stated to have been lately successfully carried out by T. Jacobi, of Adalberthütte at Kladno, near Prague, by exposing the ore to a solution of sulphurous acid in water, or to the simultaneous action of sulphurous vapors and cold water, when this acid forms a soluble compound with the lime, and at the same time converts the rest of the phosphate to the soluble form, so that it can be washed away with cold water. The inventor exhibited his process during the last meeting of the Association of German Engineers and Architects, at Prague, on November 3d, 1871. The samples of fibrous and fine grain bar-iron and puddled steel made from such dephosphorized ore, and produced to the association, were of an excellent character, and found unanimous approval. The sulphurous gas is either produced by burning sulphur or by the calcination of pyrites or other minerals containing sulphur. The same end has been attained by another engineer, B. Osann, of Potsdam, by employing in a similar way diluted hydrochloric acid, which is

obtained very cheaply in quite a novel mode. At the above-mentioned rock-salt mines of Stassfurt and Leopoldshall, large masses of chloride of magnesium are obtained, together with the salts of potassium, and are thrown away as valueless. Now, if this chloride of magnesium, which contains always a considerable amount of water, be heated to about 110° Cent. or 230° Fahr., it gives up so much water as to form a trihydrated salt of chloride of magnesium, and if this is rapidly heated to the melting point of lead it is decomposed, giving up vapors of hydrochloric acid, when hydrate of magnesia is left as a residue in the retort. The hydrochloric vapor acts exactly as was described of the sulphurous acid. Both of the processes above described are worthy of attention; but the information we have received concerning them is not as yet sufficiently, detailed to enable us to form any decided opinion regarding their practical merits.

Other metallurgists have sought to get rid of the phosphorus during the puddling of the iron, or even just before, when the pig-iron runs from the tap-hole in the moulds. For removing the phosphorus during the operation of puddling, Director Spamer, at Ilsederhütte, in Hanover, adds to each heat of 500 lbs. of pig-iron about 6 lbs. of fluoride of calcium, (fluor-spar,) which readily melts when brought in contact with the iron, so that it can be intimately mixed with it, when the fluorine combines with the silicon of the iron, to fluor silicon, and phosphoric acid is absorbed by the lime and carried into the tap cinder, or finely powdered fluor-spar is thrown into the iron-moulds before they are filled with liquid iron when tapping the blast-furnace. In both instances the result obtained is said to be excellent, the cold-shortedness of the bar-iron having entirely disappeared. This appears to be a modification of the Henderson process. (28)

NEW MODE OF DETERMINING THE QUALITY OF IRON.—M. Van Ruth suggests a method of examining the molecular arrangement of pieces of iron, whereby comparisons can be instituted, so as to aid in determining wherein goodness of quality consists, and the reverse. By the action of hydrochloric acid, for a period of from 6 to 24 hours, the inequalities of corrosion cause the fibres of the iron to stand out in relief in such manner that an impression can be obtained thereof. Thus the existence of defective structural formation may be detected, and it will be possible, so far as superficial tests can extend, to ascertain the nature and quality of any piece of iron subjected to such examination.

SEPARATION OF THE PRECIOUS METALS.

THE old way of separating gold from sand or pulverized quartz is to cause the earths to flow down through an inclined trough across which little pockets or gutters are made, in which quicksilver is placed. The latter catches and holds the particles of gold, while the earthy matter moves on and is discharged from the machine. The latest improvement is to use in lieu of the pockets sheets of copper, the surface whereof is amalgamated with mercury, over which the gold earth, reduced to a thin mud, is allowed to flow. It is found that the gold adheres better to the surface of amalgamated copper than to pure mercury. This plan is now used in the Colorado mines. A late improvement, suggested by V. Colvin, is to use amalgamated plates of zinc or iron, which he regards as superior to the copper plates, if they are treated with proper acid solutions while the auriferous earth is being run over them.

TELLURIUM.

THIS very rare metal is found at Nagyág, in Transylvania, in bodies associated with gold and silver, and Professor von Schroetler, of Vienna, has lately published a method of separating it in its pure state, in the "Reports of the Imperial Academy of Vienna." The concentrated sands or slimes obtained from the washing operations are first treated with hydrochloric acid in order to decompose or dissolve the sulphides of antimony, lead, arsenic, etc., and separated from the insoluble residue, which is then treated with aqua regia, when gold and tellurium are dissolved, and thus separated from the silver. From the solution thus obtained gold is precipitated by sulphate of iron, and tellurium by metallic zinc. The gold is melted in a graphite crucible with borax, and the tellurium in an iron pot, when both metals are obtained in a pure state, the latter being a white metal of 6.0 to 6.4 specific gravity, and of great fusibility.

THALLIUM.

THIS metal, which was discovered by means of spectral analysis, is now produced by Schaffner at the chemical works of Aussig, in Bohemia, in some quantity, the raw material being the flue-dust which collects in an intermediate chamber between the calcining kilns and the sulphuric acid lead chambers. The pyrites which are used come from the mine "Sicilia," near Meggen, in Westphalia, and the dust contains the metal in combination with sulphuric acid as "sulphate of protoxide of thallium." The raw material is boiled in a wooden vessel with acidu-

lated water, the liquid drawn off, and thallium precipitated as a chloride by additions of hydrochloric acid. The precipitate is still impure, and again dissolved in boiling sulphuric acid, when arsenic is precipitated by sulphureted hydrogen, and metallic thallium by plates of zinc, which are put in the solution. The metallic sponge is then melted in a clay or china crucible, and cast in cylindrical moulds. It can be preserved in water which has been boiled in order to drive out its contents of air. Very fine crystals of thallium may be obtained by using a weak galvanic current under the process of precipitating.

CONVERSION OF ANILINE INTO TOLUIDINE.

THIS has been accomplished by A. W. Hofmann in the following manner: By heating one molecule of aniline hydrochlorate with one molecule of methylic alcohol for many hours at 230° to 250°, there is formed a yellow transparent resinous mass of the consistency of honey, consisting for the most part of methylaniline hydrochlorate:

$$C_6H_5.HHN.HCl+CH_3.OH=C_6H_5.CH_3.HN.HCl+H_2O.$$

If the tube be now heated for a day to 350°, it undergoes a complete change. The transparent viscous fluid is converted into a beautifully crystalline mass, the secondary salt is transformed into the primary:

$$C_6H_5.CH_3.HN.HCl=(C_6H_4.CH_3)HHN.HCl.$$

The solid mass is almost completely soluble in water, and by treatment with alkali liberates the base as a brown oil, which, when distilled in an atmosphere of steam, solidifies in the receiver into a brilliant white mass of toluidine, the melting point of which is 45°. In this reaction but few by-products are formed. Aniline hydriodate furnishes a liquid toluidine. The author intends to attempt the formation in a similar way of homologues of the amines of other classes, and of some of the bases occurring in the organisms of plants.

NEW NATIVE SILVER AMALGAM.

F. PISANI.—Reference is first made to the hitherto known, and mineralogically described, native amalgams of silver. The two varieties of the mineral investigated by the author are crystalline; one has a dull silver-white color, the other a light brass-yellow. The first variety was found to contain, in 100 parts, 95.26 of silver, and 4.74 of mercury; the other, 94.94 of silver, and 5.06 of mercury. On further investigation of a sample of native crystalline silver from the same locality, the author found that it also contains mercury, but in larger quantity, namely, 13.7 per cent, and 86.3 per cent of silver; formula, Ag_6Hg.

MANUFACTURE OF RUSSIA IRON.

THE iron for this purpose is refined from pig obtained from magnetic iron ore, or red and brown hæmatites, by the use of wood charcoal and cold air. The conversion of the pig into wrought-iron is effected with wood charcoal either in the refining fire or the puddling furnace. The iron must be more granular than fibrous, and must contain sufficient carbon.

The apparatus for working consists of one or two pairs of rollers, and two kinds of hammer. The plates are again heated in ovens of special construction. The rollers should make fifty revolutions per minute. The hammers are of wrought-iron faced with steel. Each anvil consists of a block of white cast-iron. The iron plates are subjected to a process of alternately heating to redness and rolling, and finally, after heating again, they are well hammered. (32) (90)

COMPRESSED STEEL.

SOME interesting experiments have recently been carried out by M. Stummer, in order to ascertain how best to avoid the "honeycombing" of cooling masses of steel. The result of the trials was such as proves that it is possible, by exposing the semi-fluid mass to great pressure, this defect can be obviated, except for a very limited portion of the centre of the mass. In the manufacture of heavy steel ordnance, where the central portions are bored out, leaving the solid parts to form the walls of the gun, this fact will doubtless prove of service, inasmuch as the metal which is left is of the firmest texture, and capable of withstanding extraordinary strains. A pressure of from six to nine tons per square inch is found to be sufficient to compress a red-hot steel ingot, before solidification, and to give it a homogeneous structure, while the blows of the heaviest steam hammers are found to chiefly expend their force on the surface of the mass, and not to affect the interior texture.

WORKING SILVER ORES.

ACCORDING to a statement of C. M. Nes, silver may be extracted from its ore in the following manner: Melt one hundred pounds of the crushed ore with ten pounds of Codorus ore, (a magnetic silicide of iron ore.) The impurities having great affinity for the latter, will immediately unite with it and pass off as slag, leaving the silver and iron behind. These metals may then be separated by the use of a magnet, which will attract and remove the iron leaving the silver in the crucible.

MAKING IRON AND STEEL.

THE following processes for making iron "sponge" and utilizing it in the manufacture of iron and steel have been introduced by Thomas S. Blair. The ore is first crushed into pieces of suitable size and then mixed with carbon (at the rate of about eighty-five per cent of the weight of the oxygen in the ore) in the form of charcoal, coke, or anthracite coal, and is then fed into the top of a retort about three feet wide and thirty feet high. This retort has its upper two thirds inclosed in a heating chamber which may be heated by a separate furnace, one half of the remainder is surrounded by brick-work, and its lowest section (which is of iron) is set in a case through which runs a stream of water. In the top is placed a hollow cylinder about six feet long, and of such size as to leave an annular space of about four inches between it and the retort, through which the mixed ore and carbon is fed and becomes heated to the right degree before entering that part of the furnace, below the cylinder, where the heat is kept up to a bright red. As the iron becomes deoxidized, it passes into that part of the retort surrounded by brick-work and there begins to cool, and as it enters the lowest part it is further cooled by the current of water surrounding the retort, and is then removed by a sliding table (fitted to the lower end of the cylinder) containing cavities in which the sponge is received that is to be removed. As the sponge is taken from the bottom, the top of the retort is charged, so that it is always kept full and the action is continuous. As the bottom of this retort is closed by the sliding table, and the upper portion is filled with fine material, the sponge is practically kept from contact with air and does not again become oxidized, as it is too cool when it leaves the retort to be affected by the air. By this means a sponge is produced which may be utilized in making iron by the puddling process, or in making steel either in a crucible or upon an open hearth by fusing it in the presence of a proper proportion of carbon. In making iron, the sponge may be added to the charge of pig-iron in the puddling-furnace at any time after the pig-iron has become melted, and as the sponge costs less than the pig, the cost of working the mixed charge is also less, and the combined product comes to nature sooner; great economy in manufacture is the result. Another way of making iron is to work the sponge in a reverberatory furnace as if it were fine scrap, such as borings or turnings of wrought-iron; but in this case it is necessary to introduce some substance which will unite with the foreign mineral matter combined with the

sponge, and form a glass, thereby not only fluxing out the impurities from the iron, but also forming a coating that will protect the sensitive particles from oxidation. Thus treated, the sponge, as soon as sufficiently heated, comes to a welding state, and can be readily balled. In making steel by the crucible process, the sponge is finely pulverized, then heated and condensed in clay cases to protect it from air, and then treated in crucibles in the same manner as wrought-iron for the manufacture of steel; but previous to the condensation a suitable flux should be mixed with the sponge to neutralize any foreign body therein. In the open hearth process, (known as the Siemens-Martin method,) instead of the wrought-iron usually introduced into the bath of melted cast metal, the sponge is mixed therewith. It may be introduced cold in a loose state, in the form of condensed blocks, at a red heat, or it may be previously brought to a plastic state in a separate furnace. As the sponge is much cheaper than wrought-iron, the cost of making the steel is much less than by the old plan.

CRUCIBLES.

IN pouring metal into moulds from crucibles, it usually requires two persons, one to pour and the other to keep the dross or oxide from entering the mould, and it has been suggested by J. L. North that, by making a crucible with a pouring-place just below the top, the dross would be retained in the crucible, as the rim over the aperture would serve as a skimmer, and the service of an assistant be thereby dispensed with.

CASTING METAL.

A METHOD of casting metal in which it is kept from contact with air during the process of running has been devised by William Sellers, in which the air is exhausted from the mould, and the short leg of a siphon tube connected with it is dipped into the melted metal, and the pressure of the atmosphere forces it through the siphon into the mould. The tube is heated to prevent chilling the metal, and as the air does not come in contact with the latter, oxidation is prevented.

PUDDLING-FURNACE.

IT is stated by Messrs. A. and J. Reese, that by making the bed of a puddling-furnace of double the usual length, or rather, having two beds, connected by a short neck, so arranged that the heat from the grates will pass from one bed to the other, that double the amount of iron can be puddled with but a small, if any, increase of the fuel used.

MAKING IRON FROM MILL-CINDER.

LARGE quantities of mill-cinders containing from forty-five to fifty per cent of iron are thrown away as useless at rolling-mills, and large amounts of fine charcoal and anthracite coal-dust are also wasted in the same manner. To utilize these substances, Charles M. Nes grinds the mill-cinder fine, washes out the lighter parts, and adds to each one hundred pounds of the cinder ten pounds of Codorus ore, (a magnetic silicide of iron ore,) forty pounds of coal-dust, and twenty pounds of burnt lime. These ingredients are mixed with water, moulded into blocks, dried in the air, placed in a blast-furnace, and treated as ordinary ore. The cinder being already carbonized, can be readily reduced, the lime acting as a flux, causing the metal to separate from the cinder, and the phosphorus and other impurities, having a great affinity for the magnetic ore, pass off as slag.

ANHYDROUS LIQUEFIED AMMONIA.

BY G. GORE, F.R.S.—This investigation was made for the purpose of ascertaining the general solvent properties of the liquid, and to detect any manifest chemical reactions between it and various substances.

Two hundred and fifty substances were submitted to contact with the liquid, and the general results in each case recorded. The only elementary substances soluble in it were the alkali-metals proper, also iodine, (bromine was not tried,) sulphur, and phosphorus. The more frequently soluble inorganic salts were nitrates, chlorides, bromides, and iodides; whilst oxides, fluorides, carbonates, sulphides, and sulphates were very generally insoluble. Many saline substances, especially certain chlorides, bromides, iodides, and sulphates, absorbed ammonia freely, and swelled greatly, but did not dissolve. The behavior of the chlorides of mercury was peculiar.

Various compounds of carbon were submitted to the action of the solution of potassium in the liquefied vapor; the free potassium disappeared, but no elementary carbon was liberated.

REDUCING AND CONVERTING-FURNACE.—A furnace designed by George T. Wilson has a reducing-chamber on one side and a converter on the other, with a passage between, so that the iron melted in the reducing-chamber may be run directly into the converter, where it is treated with air, as in the Bessemer process. The two chambers are so arranged that the converter is heated by the gases from the reducing-chamber.

CHEMISTRY OF THE GREAT FIRE IN BOSTON.*

A CONFLAGRATION so extensive and destructive as that which laid waste a considerable portion of the city of Boston in November must be interesting and instructive in its chemical aspects, and we design to briefly direct attention to some of these. The process of combustion, whether it involves immense structures, or is confined to the narrow limits of a candle or common friction-match, is strictly a chemical process. The burning of Boston was a chemical experiment on a vast scale, and withal so costly that the spectators hardly wish to see it repeated. To burn a substance is simply to change its condition; the matter involved is not destroyed, but from chemical action it is forced into new relationships, or into new forms of matter. There was nothing whatever actually *destroyed* by fire in this city on the night of November 9th, but an immense amount of material was changed from a valuable or marketable condition into one having no value. The sugar, coffee, tea, and spices of the grocer; the prints, flannels, laces, and silks of the dry-goods dealer; the opium, gums, oils, and extracts of the druggist; the salts, acids, alkaloids, and reagents of the chemist, consumed on that night, were but common and valueless elements thrown into complex combinations by nature or art, so as to meet or supply human wants. In the condition in which the hydrogen, carbon, oxygen, nitrogen, the metals, etc., existed, of which these diversified substances were composed, they were needful to feed us, keep us warm, or relieve us when ill; they therefore, as related to our wants, had value; we were willing to exchange gold for them, a metal of such noble characteristics and so sparsely disseminated upon our planet that we find it to be

* November 9th, 1872, the chief business portion of the city of Boston was burned. Sixty-four acres of her finest buildings were made a heap of ruins. The district burned over was bounded by Summer, Washington, Milk, Congress, Water, Kilby, and half of Central streets, proceeding therefrom in nearly a straight line to Broad street, and thence to the Boston, Hartford, and Erie Railroad depot. In it are included Otis, Arch, Hawley, Franklin, Devonshire, Matthews, Perkins, High, Purchase, and Pearl streets, besides a large number of alleys and places. The fire was discovered on Saturday evening—the 9th; and before the engines could arrive, it had so spread that, favored by a strong wind, in less than half an hour it was beyond control. So fierce and terrible was the heat that it was impossible for the firemen to remain at their posts; and the granite front walls, of which many of the buildings were composed, cracked and exploded, falling in fragments upon the street. No structure, however massive, opposed the slightest resistance to the flames. Aid was obtained from adjacent cities; and after twenty-four hours' labor, and the blowing up of several blocks of splendid buildings, the fire was at last brought under control. But in the course of a few hours it broke out afresh, owing to gas explosions, the result of negligence in not shutting off the mains leading into the burned district. Thirty-six hours in all elapsed before the fire was fully reduced. The estimated loss was ninety millions of dollars. Seven hundred buildings, embracing, perhaps, the finest specimens of city architecture in the world, were destroyed.

a convenient representative of value. We had toiled for months or years to form these chemical substances and fabrics, or we had sent our ships to every point of the globe to gather them up, and we had stored them safely, as we supposed, in our warehouses. But the fire came, and in sixteen hours the whole was resolved into carbonic oxide, carbonic acid, water, and a few tons of ash; products which we can neither eat, wear, nor utilize in any way to advantage. We do not need the forms of matter which the fire left for us, but we did need the same elements in the other forms, as we had them before the conflagration.

Combustion is a wonderful process. It may go on rapidly, as it did in November, and lay waste a city in a single night, or it may proceed slowly, and require centuries to effect the same changes. Our immense stores of merchandise, which were resolved so rapidly into invisible forms, would have passed through the same changes—in short, would have been burned—if no fire had come nigh them. This result would have been inevitable, if we had consumed them as food, worn them as clothing, or allowed them to waste from neglect. The burning would have been as actual as that of which we were eyewitnesses. The same amount of heat would have been developed, and the resultant products the same. All organized bodies are constantly undergoing a process of decay, which is slow combustion, and although we do not see the light or feel the heat, it is accompanied by them. The world of organized matter is certainly destined to be burned, but we prefer the slow form to the rapid, as we have had a notable example of the latter which will suffice for a lifetime.

It is quite easy to understand that wood and other organized bodies can burn; but the combustion of buildings constructed of brick, stone, and iron presents a problem not a little puzzling to many. A fire, sweeping through the streets of a city, lays low whole blocks of buildings, into which nothing combustible enters, save the wooden partitions, floors, and stair-cases, and these while burning afford combustible material enough to expand and topple over our thin walls, and render the ruin complete. Buildings considered fire-proof, that is, those constructed without wood, can be destroyed by fire, if any ignitible material is burned within them. The Palace of the Tuileries and the Hôtel de Ville, in Paris, burned by the wretched Commune, were fire-proof buildings, and without the aid of our American kerosene oil or some similar inflammable material they could not have been ruined as they were. It required nearly three hundred barrels of kerosene oil to destroy the Tuileries. The miscreants hoisted a barrel or

more into each room, and knocking out the heads, allowed it to flow over the building, and when it was thoroughly saturated, they set it on fire. The metal and stone used in the structure were rapidly expanded by the intense heat, the walls were pushed outwards, the roof fell in, and the destruction was complete.

Our Boston fire has demonstrated the influence which extreme heat has upon granite structures. They do not withstand its influence so well as those built of brick, and therefore are not as safe buildings in time of large conflagrations. Pearl street was lined with granite buildings, and after the fire the work of disintegration was so thoroughly accomplished that fine granitic sand covered the pavement several inches deep. Water we recognize as the antagonist of fire, and it was most liberally supplied in our great conflagration. It seems a little paradoxical at first view, the act of pouring an agent on to a fire with the design of arresting it when we remember that the fluid itself is composed of two elements, one of which is highly combustile and the other the grand supporter of combustion. It has been stated in several journals, that water thrown upon the fire in the form of spray was decomposed into its gaseous condition, and therefore actually fed the flames. Now this is not correct. We doubt if a single one of the millions of gallons employed was thus decomposed. It requires a most intense heat, equal to that of a blast-furnace, to decompose water, and it also must be accomplished under peculiar conditions. Water thrown upon buildings is often dissipated in steam by contact with flame before it reaches the burning body. Most of that used in this city was thus rendered ineffective, as the buildings were high, and the water was subdivided into mist before reaching the point upon which it was directed. Water quenches fire by physical contact with the burning body, covering it, and thereby excluding the contact of atmospheric oxygen; also, it instantly reduces the temperature of ignited substances, by vaporization. By the sudden change from a liquid to vapor, it robs the substance of the heat necessary to keep up combustion, which is thus extinguished.

It is certain that we must seek new devices for subduing fires in large cities, and we will describe a plan which we think would prove practicable and effective. The plan is based upon the idea that every building must depend upon its own apparatus, and not upon that belonging to any municipality. Twenty years ago we employed carbonic acid water for quenching fires, long before any of the so-called fire annihilators were used, and it is an agent so

effective, and so easily and cheaply produced, that it must come into general use. Our plan is to place in the basement of every warehouse or store an iron vessel resembling a steam boiler, the capacity to depend upon the size of the building. This is to be kept two-thirds full of water, the chamber above the water to hold two glass vessels, one of which is filled with acid, the other with bicarbonate of soda. By a very simple device, these glass vessels may be broken at any moment, so that the substances will instantly develop carbonic acid, which, being absorbed by the water, changes it into aërated, or carbonic acid water. The gas over the water affords immense pressure, and by pipes leading from the strong iron fountain, the gas-impregnated water may be directed at once upon the fire in its incipient stages, in any portion of the building. One gallon of this water is as effective as ten of common water, and therefore can be used to extinguish a fire without the great water damage to goods which often results. The time is not far distant when apparatus of this kind will be regarded as much of an essential appendage to buildings which contain large quantities of valuable merchandise, as are gas pipes, or water-closets.

The burning of our warehouse, at the time of the great fire, filled with chemical products, was in one sense an interesting exhibition. We can not say that it was calculated to awaken much enthusiasm so far as we were personally concerned, as the spectacle was a little too costly for that. It was paying too high for the pyrotechny, no matter how grand the display. The nature of the substances burned was peculiar, affording intense heat and flames of divers and gorgeous colors. Numerous packages of the salts of strontium, calcium, magnesium, potassium, copper, barium, etc., were consumed, which produced a variety of brilliant illuminations, and these, with alcoholic preparations, carbolic acid, nitrate of ammonia, and hundreds of other highly combustible bodies, gave to the flames a fierceness and coloring not observed elsewhere. The brick vault in which were deposited our account-books and valuable papers, was in the midst of the fiery furnace, and subjected to the full fury of the flames. Owing to the great heat, it could not be reached until five days after the fire, and when opened, the contents were found to be in most perfect condition. The safe was a brick structure, carried up from the ground through the basement, having two iron doors, the space between the outer and inner being fourteen inches. The doors were about three eighths of an inch in thickness, and without transverse bars or bolts, or other fastenings, save one common lock.

Apprehensive that these frail iron doors would not withstand intense heat in case of fire, we directed the American Steam Safe Company, two years ago, to put upon the inside of both twelve copper reservoirs of water, each holding about a gallon. These were constructed after their pattern, being sealed with a fusible plug. On the night of fire, just before the store was burned, several of the young men employed in the counting-room gained access to the vault, opened it, and placed three wooden pails, filled with water, upon the floor; they then closed the inner door, and before locking the outer, placed two more pails full of water in the space between the two. This was indeed a thoughtful act in time of so much excitement. We expected not only that the wooden pails behind the first door would be burned, but those in the interior of the vault; and therefore great was our surprise to find upon examination that they were entirely unharmed, and each pail contained a little water. Those in the interior contained nearly the same amount as when placed there. The copper reservoirs attached to the interior surface of the first door were entirely empty; those upon the second held about one third of their contents. It is clear that we are indebted to the agency of *steam* for the preservation of the valuable contents of our safe. The reservoirs upon the first door held water sufficient to maintain an atmosphere of steam in the space, during the time the fire was most intense; afterward the heat was conducted through to the second, when the boiling water filled the vault itself with steam, and prevented the papers from igniting. Without the reservoirs upon the outer door, the two water-pails would have been burned before their contents could have been evaporated, and the flames would have found access to the vault through the inner door, had it not been protected. We used an iron safe, of an approved pattern, in the counting-room, as a matter of convenience, not trusting, however, any papers of value in it. This safe was taken from the ruins burned through and through. It afforded no more protection than would a wooden box. The plan adopted by the American Steam Safe Company of this city, of using water reservoirs as a lining, is an excellent one. So long as the water lasts, steam is present in the cavity, and the temperature can not rise high enough to ignite or char paper. Every bank vault in the country, and every brick or stone chamber, in which valuables are kept, should have the doors covered on the inside with water reservoirs.—*Boston Journal of Applied Chemistry.*

NEW PROCESS FOR THE MANUFACTURE OF IODIDE OF POTASSIUM.

BY E. SONSTADT.—This process consists in converting the alkaline iodides, contained in the mother-liquors from kelp, into iodates; precipitating the iodic acid by a soluble barium salt; heating the precipitate with solution of sulphate of potassium, which gives iodate of potassium in solution; drying up and melting the iodate of potassium solution; and crystallizing the solution of the melted iodide of potassium thus obtained.

The conversion of iodides into iodates in the mother-liquors is effected by one of the following processes. But it is advisable, first, to partially or completely precipitate the sulphuric acid from the mother-liquor by solution of chloride of barium or other suitable barium salt, as thus silicic acid, if present, and other impurities are separated, and the precipitate afterward obtained of iodate of barium is more manageable. The mother-liquor is then, after separation of the precipitate, melted, to destroy organic matter. The melted mass is dissolved in water, and the solution, after separation from the residue, is, if intended for treatment by any of the processes except the last undermentioned, rendered alkaline by addition of a caustic or carbonated alkali, to such extent that the liquid may contain, for each atom of an iodide in it, five atoms of a caustic alkali, or ten atoms of a carbonated alkali. The liquid thus prepared may then be treated by any of the following processes for conversion of the iodide in it into iodate.

(1.) Chlorine is passed through the liquid until the whole of the iodide is transformed into iodate, but no longer.

(2.) Solution of a permanganate is added until a slight permanent coloration of permanganate remains. The liquid is then separated from the manganese precipitate, which latter may be furnaced with soda, or with soda and nitre, to re-form permanganate for another operation.

(3.) By passing an electric current through the dilute solution in the way usual in electrolysis. This process would be convenient and economical where the electricity can be obtained from electro-magnetic machines worked by water-power.

(4.) In this process, the purified mother-liquor is dried up with addition of an atom of an alkaline chlorate for each atom of an iodate present. The mixture is then cautiously heated below redness until the iodide is converted into iodate.

After the iodic acid is separated from the mother-liquors, the bromide remaining in solution may be con-

verted into bromate by either the processes (1) or (4), and bromide of potassium obtained by the same methods as used for obtaining iodide of potassium. Processes (2) and (3) are not applicable to the formation of bromate.

ATMOSPHERIC OZONE.

By A. Houzeau.—In this paper the author, after giving a history of the researches upon atmospheric ozone since its discovery by Schönbein, describes the reagent with which his own observations have been made, namely, red litmus-paper impregnated over half its surface with a 1 per cent neutral solution of potassium iodide.

This paper in contact with ozone assumes a blue color only in the part impregnated with the iodide, this change of color being due, not to the liberation of iodine, but to oxidation of the potassium, the alkali thus formed changing the color of the litmus. In this respect the iodized litmus-paper is preferable to iodized starch-paper, (Schönbein's reagent,) which turns blue when the iodine is set free, and will therefore exhibit this reaction over its entire surface under the influence of free acids, especially nitrous acid, as well as of ozone. The part of the litmus-paper which is not iodized serves to reveal the accidental presence in the air of alkaline vapors (free ammonia, ammonium carbonate, etc.) which turn the red litmus-paper blue throughout its whole length; it is impossible, therefore, to mistake the indications. Moreover, the iodized litmus-paper can not be turned blue by chlorine, bromine, etc., since the chloride and bromide of potassium are neutral.

From a large number of observations made with this reagent in various localities and at different times of the year the following conclusions are drawn:

1. The air of the country contains an odoriferous and oxidizing principle which imparts to it a peculiar odor, and the power of bluing iodized red litmus-paper; also of decolorizing blue litmus-paper without previously reddening it; and of destroying certain bad smells.

2. That this principle is ozone.

3. That ozone exists in the air normally, but that the intensity with which it acts at any given point of the atmosphere is often very variable.

4. That the air of the country contains at most about $\frac{1}{4300000}$ of its weight, or $\frac{1}{7000000}$ of its volume of ozone.

5. That the manifestation of ozone by the iodized litmus-papers is much more frequent in the country than in town.

6. That this difference may be due to the greater circulation of air in the fields.

7. That at Rouen, the frequency of the ozone manifes, tations varies with the seasons, being greatest in spring-strong in summer, weaker in autumn, and still weaker in winter.

8. That the maximum of ozone manifestation occurs in May and June, (16 ozone days per month,) and the minimum in December and January, (4 ozone days per month.)

9. That with respect to the frequency of ozone manifestation, the meteorological year in our climates may be divided into two great seasons; the *very active season*, (spring and summer,) comprising 78 ozone days, and the *feebly active season*, (autumn and winter,) including 32.

10. That in general ozone shows itself most frequently on rainy days, (48 ozone days in a hundred of rain, to 28 in a hundred of fine weather.)

11. That winds, according to their strength, exert the greatest influence on the manifestation of ozone, (24 ozone days in 100 when the air was calm or but slightly agitated, and 60 in 100 when the air was greatly disturbed.)

12. That at Rouen, the largest number of ozone days occur when the wind is in the west or south-west, the smallest number when it is in the east.

13. That most frequently an exaggerated manifestation of ozone is in intimate relation to the great atmospheric perturbations, known as storms, gales, and hurricanes, (*orages, bourrasques, ouragans.*)

14. That these great commotions of the atmosphere act at very great distances. Sometimes they momentarily affect the ozone of entire towns and localities, which nevertheless continue to enjoy very fine weather.

15. That atmospheric electricity appears to be the most active cause of the formation of atmospheric ozone.

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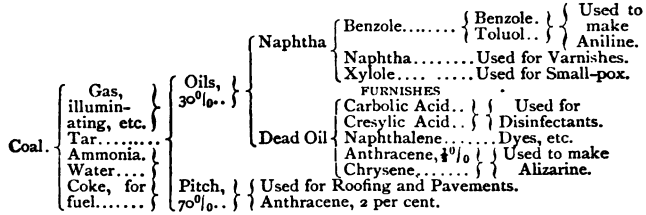
RUBIDIUM IN PLANTS.

It has been found by E. Pfeiffer that this metal is present in the ash of the beet-root grown in the north of France, one kilogramme containing on an average 1.75 grammes of the chloride of this metal, or the plants grown on one hectare (2 acres, 1 rd., 35 p.) of land will take up 255 grammes of the chloride of this metal from the soil. The ratios of the chlorides of rubidium, sodium, and potassium in the ash of the beet of this district are as 1 : 126 : 331. Grandeau has likewise detected cæsium in these chlorides. While the beet takes up no lithium, the tobacco grown in this district contains potassium, rubidium, and lithium, but only a trace of sodium. The rape grown in this locality contains potassium and sodium, but absorbs neither rubidium nor lithium.

PRODUCTS OBTAINED FROM COAL.

BY HENRY A. MOTT, JR.



The preparation of alizarine from anthracene:

Anthracene. Acetic Acid. Potassic bichromate. Anthraquinone.

$$\overbrace{C_{14}H_{10}} + \overbrace{C_2H_4O_2} + \overbrace{K_2Cr_2O_7} = \overbrace{C_{14}HO_2} + \text{etc.}$$

Anthraquinone. Bromine. Dibromoanthraquinone.

$$\overbrace{C_{14}H_8O_2} + \overbrace{2Br} = \overbrace{C_{14}H_6Br_2O_2} + \text{etc.}$$

Dibromoanthraquinone. Potassic hydrate. Alizarine.

$$\overbrace{C_{14}H_6Br_2O_2} + \overbrace{2HKO} = \overbrace{C_{14}H_8O_4} + \text{etc.}$$

The following table gives a list of the products obtained by the distillation of coal:

NAME.	Formula.	Gas or Vapor. Specific Gravity.	Boiling Point. Degrees.
Atmospheric air.....	....	1.000	...
Hydrogen.....	H	0.069	...
Nitrogen.	N	0.971	...
Oxygen.....	O	1.106	...
Ammonia.....	NH_3	0.590	33
Aqueous vapor.....	H_2O	0.622	100
Carbonic oxide.....	CO	0.967	. .
Carbonic anhydride.....	CO_2	1.529	109 (Fah.)
Cyanogen.....	CN	1.801	...
Sulphurous anhydride...	SO_2	2.2112	+13.09(Fah.)
Carbon disulphide.....	CS_2	2.645	47
MARSH GAS SERIES.			
Methyl hydride.....	CH_4	0.5596	...
Ethyl hydride.....	C_2H_6	1.037	...
Propyl hydride.....	C_3H_8	1.522	...
Butyl hydride.....	C_4H_{10}	2.005	9
Amyl hydride.....	C_5H_{12}	2.489	30
Hexyl hydride.....	C_6H_{14}	0.669	65
Octyl hydride	C_8H_{18}	0.726	108
Decyl hydride.....	$C_{10}H_{22}$	.....	158
OLEFIANT GAS SERIES.			
Methylene.....	CH_2	0.484	39
Ethylene (olefiant gas)...	C_2H_4	0.9784	...
Propylene (tritylene)....	C_3H_6	1.452	—17.8
Butylene.....	C_4H_8	1.936	+35

Name.	Formula.	Gas or Vapor. Specific Gravity.	Boiling Point. Degrees.
Amylene	C_5H_{10}	2.419	55
Caproylene (hexylene)	C_6H_{12}	2.97	61.3
Œnanthylene	C_7H_{14}	3.320	99
ACIDS.			
Hydrosulphocyanic	H (C N) S	....	85
Hydrosulphuric	H_2S	1.175	...
Carbolic (phenol)	H (C_6H_5) O	1.065 (solid).	188
Rosolic	$C_{20}H_6O_3$	....	...
Brunolic	.....	.....	...
Hydrocyanic	H C N	0.7058	26.5
Acetic	$C_2H_4O_2$	2.079	120
ALCOHOLS.			
Cresylic alcohol	C_7H_8O	.....	203
Phlorylic alcohol	$C_8H_{10}O$	.....	...
BENZOLE SERIES.			
Benzole	C_6H_6	2.695	82
Toluole	C_7H_8	3.179	111
Xylole	C_8H_{10}	3.179	129
Cumole	C_9H_{12}	4.147	148
Cymole	$C_{10}H_{14}$	4.632	175
Naphthalene	$C_{10}H_8$	4.423	212
Anthracene	$C_{14}H_{10}$	6.741	melts at 213
Chrysene	C_6H_4	.....	...
Pyrene	$C_{15}H_4$	.....	...
		Sp.Gr.H_2O=1	
Aniline	$H_2(C_6H_5)N$	1.020	182
Pyridine	$(C_5A_5)N$	.....	115
Picoline	$(C_6H_7)N$	.09613	134
Lutidine	$(C_7H_9)N$	.921	154
Collidine	$(C_8H_{11})N$	.....	170
Parvoline	$(C_9H_{13})N$	.....	188
Coridine	$(C_{10}H_{15})N$	.....	211
Rubidine	$(C_{11}H_{17})N$	....	230
Viridine	$(C_{12}H_9)N$	1.017	251
Lecoline	$(C_9H_7)N$	.....	235
Lepidine	$(C_{10}H_9)N$	.....	260
Cryptidine	$(C_{11}H_{11})N$	....	256
Pyrrol	$(C_4H_5)N$	.....	133 (69)

DECOLORIZING ACTION OF ANIMAL CHARCOAL.

DR. H. SCHWARZ records the results of a series of experiments made with the view of ascertaining whether, by igniting bone-ash with organic substances, such as glue, size, sugar, etc., a good decolorizing charcoal is formed, and also whether the spent animal black can be revivified to its former strength by a similar process. It appears from the author's extensive researches that animal black may be entirely revivified in closed vessels by ignition with organic matter, which need not be nitrogenous.

CYMENE FROM TURPENTINE AND FROM LEMON OIL.

By A. Oppenheim.—The object of this research was, if possible, to obtain some insight into the constitution of the isomeric ethereal oils by studying the cymenes obtained from them by the abstraction of a molecule of hydrogen. The terpene and citrene, boiling at 160°–161° and 173°–174° respectively, were first converted into the dibromides by the cautious addition of a molecule of bromine to the well cooled oils. After numerous trials, the author found that the best method of eliminating the two molecules of hydrobromic acid from these bromides was to heat them with a slight excess of aniline to 180° for eight hours; by this process a yield of 30 per cent of the theoretical amount of cymene was obtained. The boiling point of the hydrocarbon, from either source, was between 176° and 179°, and by oxidation with potassium bichromate and sulphuric acid it yielded terephthalic acid and acetic acid, showing that in both the cymenes the side chains consist of ethyl and normal propyl, and that their relative position is the same. The two cymenes would therefore appear to be identical, and terpene and citrene to consist of the same cymene combined with two atoms of hydrogen, differing from each other only in the relative position of the latter. It must be remembered, however, that the yield of terephthalic acid is much less than that indicated by theory, so that the acetic acid may be produced by the oxidation of a portion of the aromatic compound, and not of the side chain.

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ARTIFICIAL FORMATION OF CAMPHOR.

By A. Oppenheim.—During some experiments made to determine whether the cymene from turpentine consisted of several isomeric modifications or only one, the author completely oxidized some of the former hydrocarbon, and obtained in the upright condensing tube a small quantity of a white crystalline substance having the appearance, odor, and composition of camphor. It sublimed readily, and melted at 162°, which is nearly the same melting point as that of camphor, (176°,) the difference being probably due to the presence of a small amount of impurity. A sublimate, having the same melting point, was also obtained in the oxidation of the cymene from citrene. This compound does not appear to be produced under the same circumstances from turpentine; neither did terpene dibromide yield it by treatment with silver oxide or with silver salts.

(69) (32)

THEORY OF FERMENTS.

BY DR. L. PASTEUR.—I have for a considerable time considered fermentation (properly so called) to be a chemical phenomenon correlative with physiological actions of a peculiar nature, and I had previously proved that the ferments which excite fermentation are not dead albumenoid matters, but living organisms. I have induced the fermentation of sugar, lactic and tartaric acid, and glycerine, in fact all kinds of fermentation, in mediums exclusively mineral, thus affording incontestable evidence that the decomposition of fermentable matter is correlative with the life of the ferment, so that it is one of its essential foods. For instance, under the conditions just alluded to it is impossible that there should be, in the constitution of the ferments which are generated, a single atom of carbon which is not derived from matter suitable for fermentation. The chemical phenomena of fermentation are distinguished from many others, and more particularly from those of the acts of life in its ordinary sense, by the fact of the decomposition of a far greater weight of fermentable matter than that of the ferment in action.

I have long thought that this particular character is related to that of nutrition without contact of free oxygen. Ferments might therefore be considered as living beings, but endowed with a life, *sui generis*, in the sense that they possess the property of accomplishing all acts of life, procreation inclusive, without in any way requiring atmospheric oxygen. The mind here recurs to those singular infusoria which induce butyric or tartaric fermentations, or certain putrefactions, and which not only live and multiply without oxygen, but are even killed and cease to induce fermentation as soon as oxygen gas is dissolved in the liquid, or soft semi-solid substance, in which they live. By direct experiments made with beer-yeast I have found that, if the life of that very small cellular plant were partly dependent upon oxygen, it would, according to the proportion of intensity of that influence, partly lose its character of ferment; that is to say, the weight of yeast formed under these conditions during the decomposition of the sugar would gradually become greater, and approximate to the weight of decomposed sugar when gradually the life of the yeast-plants continues to linger on in the presence of increasing quantities of free oxygen. Guided by these facts, I have been led to consider fermentation as a *conditio sine qua non* of the manifestation of life, when that life exists beyond the direct combustion due to free oxygen gas. As a consequence of this theory, we may consider that every being, every organ,

every cell, which lives, or can continue to live, for any length of time, either without any atmospheric oxygen at all, or only in a very limited proportion, for its whole existence, is to be regarded as possessing the character of a ferment in reference to the substance which supplies it either wholly or in conjunction with heat. This substance must of necessity be oxygenated or carbonated, since, as already stated, it yields food to the ferment; because all *fermentescible* substances contain these two elementary substances. (4) (2)

A NEW NITRIC HYDRATE.

ON cooling the lower layer of the distillate from nitric acid and phosphoric anhydride in a freezing mixture, the new nitric hydrate crystallizes out. It can also be prepared by adding nitric anhydride to nitric acid. The anhydride dissolves with development of heat until the new hydrate, $2N_2O_5.H_2O$, is produced, but any further quantity of it remains insoluble. The pure hydrate is obtained by crystallizing it out in a freezing mixture, draining it from the mother-liquor, allowing it to melt, and again crystallizing it. Both this hydrate and the anhydride have been analyzed. In its chemical properties the hydrate resembles the anhydride. It is liquid at ordinary temperatures, but less so than the ordinary hydrate, and more or less yellow-colored; solid at about —5°. Its specific gravity at 18° is 1.642. It slowly decomposes at ordinary temperatures. When heated it partly distills unchanged, but nitric anhydride is also formed, so that the distillate consists of two layers, the upper being the anhydride. In this decomposition it resembles fuming sulphuric acid.

When nitric acid is distilled with fuming sulphuric acid, oxygen, nitrous vapors, and a compound of the composition $SO_3N_2O_3.3SO_3H_2O$ come over. (88) (32)

TRANSPARENT CRYSTALS OF SALT.

MOHR showed that salt was deposited in crystals resembling rock-salt by allowing its solution to become supersaturated by very slow evaporation, and inducing the excess to deposit, not at the surface of the liquid, but on the bottom of the vessel. It has recently been noticed by Buchner that the same thing happens on introducing a hygroscopic salt of some kind into a concentrated solution of sodium chloride. When iron chloride or magnesium chloride is used, the cubes are perfectly transparent, and exactly resemble rock-salt. It is highly probable that the larger proportion of magnesium chloride met with in the mother-liquors of salt-beds may have been an active agent in the deposition of the rock-salt.

NITRIC ANHYDRIDE.—A NEW NITRIC HYDRATE.

By Rudolph Weber.—The most concentrated nitric acid, freed from nitrous acid as much as possible, and cooled by ice, is treated with phosphoric anhydride, which, as it acts upon it very violently at first, is added slowly and in small quantities at a time. The syrupy product is distilled so long as any thing comes over at a blood-heat, and condenses in oily drops in the neck of the retort; the two layers of liquid, of which the distillate is found to consist, are separated by decantation, the lower layer being an impure new nitric hydrate. The upper layer, which consists of nitric anhydride, nitrous acid, and some hydrate, is cooled by ice-water, which renders it turbid, and causes a small quantity of a clear, colored liquid to separate. This liquid, which consists of nitric anhydride and nitrous acid, is further cooled by ice or a freezing mixture, when some of the nitric anhydride crystallizes in well-formed, transparent, yellowish prisms, leaving a liquid compound of nitric anhydride and nitrous acid, which appears to be richer in the former than nitroso-nitric acid. Lastly, the anhydride is purified by cautiously fusing it, again crystallizing it by cold, and draining off the mother-liquor.

The melting-point of nitric anhydride thus prepared is about 30°. It is very unstable, particularly in the fused state, but can be preserved for several days at 10° in a dry atmosphere. It is volatile at ordinary temperatures, and its vapor condenses in beautiful crystals in the cooler part of the tube containing it. In a freezing mixture it is almost colorless. The specific gravity of the solid anhydride exceeds 1.64; that of the liquefied anhydride is less than 1.636.

It acts with great violence upon sulphur, forming a compound of sulphuric anhydride and nitrous acid. It also acts with great energy upon phosphorus, potassium, and sodium, setting them on fire. Upon organic substances it also acts with great intensity. It does not act upon charcoal, but this substance, when previously kindled, burns with great brilliancy in its vapor. It acts upon zinc, cadmium, mercury, and arsenic, and slightly upon magnesium and thallium, but has no action upon most other metals.

Cooking under Pressure.—Experiments by Professor Junichen prove that the time for cooking various articles of daily consumption is very much shorter when effected under strong pressure, while a great saving in fuel is also obtained.

NEW METHOD OF SPECTRAL ANALYSIS.

BY TIMIRAESEF.—The telescope of an ordinary spectroscope is replaced by a microscope, which is so placed that the spectrum may be reflected by the plane mirror. Under the stage is placed an objective which can be so adjusted as to make the spectrum-image fall in the same plane as the object to be investigated. One half of the slit being now screened by the solution of which it is desired to produce the absorption-spectrum, the observer perceives the continuous spectrum and the absorption spectrum side by side. The latter can now be conveniently compared with the lines produced in the former by the solid object on the stage. The absorption-spectrum of single grains of chlorophyll was thus found to be identical with that of its solution; and the displacement of the skin-absorption lines, which has been observed when whole leaves are submitted to examination, was found to arise from the superposition of spectra.

COAL-MINES OF GREAT BRITAIN.

MR. HACKING stated recently, before the Scientific and Mechanical Society of Manchester, that there were now about 33,000 coal-mines in the United Kingdom, from which the enormous quantity of 120,000,000 tons of coal were raised annually. The depths at which these black treasures, constituting such an all-important ingredient in the wealth of this country, were stored varies very much, the deepest workings in this country being the Dakinfield and the Rosebridge collieries, near Wigan, which latter had a depth of 2418 feet, and the average temperature was about 95° F. The danger attending the getting of coal was very great; this was partly due to the peculiar position in which the miner was placed, and partly to the terrible agencies reigning at these depths. A great difficulty was to obtain an efficient supply of pure air, for which mechanical means had almost invariably to be adopted. A very common mode of ventilation was by means of one, two, or three shafts; at or near the bottom of one, the upcast, a fire was kept which rarefied the air above, in consequence of which new air rushed in from the downcast, which had to make its way through the workings, and lastly to the fire.

The life of those employed in the pits was much endangered by what was called "fire-damp," which was light carbureted hydrogen (C_2H_4) mixed in certain proportions with that is the same, atmospheric air. The issued from the pores and crevices of the cave, but if atmospheric air contained

more than 7⅓ per cent., and less than 13 per cent., the result was most terrible; if that mixture came in contact with a naked flame it would then explode. The supply of pure air was therefore required to be very ample in order to keep the mixture below the explosive point. As a rise in the barometer indicated a decrease in the pressure of the atmosphere, a larger quantity of the gas would always be liberated when such a rise took place, and he suggested registering-barometers, which might be made to actuate an alarm as a safeguard.

GLYCERINE AS A SOLVENT.

KLEVER has estimated the solubilities of a number of substances in glycerine. The following are his results: At the ordinary temperature 100 parts of glycerine dissolve

98	parts	of Carbonate of soda.
60	"	Borate of soda.
50	"	Arseniate of potash.
50	"	Arseniate of soda.
50	"	Chloride of zinc.
50	"	Tannin.
50	"	Urea.
40	"	Alum.
40	"	Iodide of potassium.
40	"	Iodide of zinc.
35	"	Sulphate of zinc.
33	"	Sulphate of atropine.
33	"	Cyanide of potassium.
30	"	Sulphate of copper.
27	"	Cyanide of mercury.
25	"	Bromide of potassium.
25	"	Protosulphate of iron.
22.5	"	Sulphate of strychnine.
20	"	Acetate of morphine.
20	"	Acetate of lead.
20	"	Arsenious acid.
20	"	Arsenic acid.
20	"	Carbonate of ammonia.
20	"	Chlorate of soda.
20	"	Hydrochlorate of ammonia.
20	"	Hydrochlorate of morphia.
16	parts	of Lactate of protoxide of iron.
15	"	Oxalic acid.
10	"	Acetate of copper.
10	"	Boracic acid.
10	"	Benzoic acid.
10	"	Chloride of barium.
8	"	Bicarbonate of soda.
8	"	Tartrate of iron.
7.5	"	Bichloride of mercury,
6.7	"	Sulphate of cinchonine.
5.5	"	Tartar emetic.
5	"	Polysulphuret of calcium.
4	"	Nitrate of strychnine.
3.5	"	Chlorate. of potash.
3	"	Atropine.
2.25	"	Brucine.
1.90	"	Iodine.
1	"	Veratrine.
0.50	"	Cinchonine.
0.50	"	Quinine.
0.45	"	Morphine.
0.25	"	Tannate of quinine.
0.25	"	Strychnine.
0.20	"	Phosphorus.
0.10	"	Sulphur.

CAUSTIC SODA.

BY TESSIE DU MOTAY.—When one equivalent of sulphuret of sodium is mixed and fused with one equivalent each of caustic soda, hydrate of lime, and metallic iron, (either cast or malleable,) and these substances heated to redness, the sulphuret of sodium is completely converted into caustic soda, while sulphuret of iron is simultaneously formed. This reaction is explained by the author as follows: The water of the hydrate of soda, or of the hydrate of lime, is decomposed by the iron, which becomes oxidized, hydrogen is set free, oxide of sodium formed, and next sulphuret of iron; the soda is separated from the last-named substance by lixiviation with water.

SPECIFIC HEAT OF CARBON.

IT was held by Dulong and Petit, as a result of their experiments on twelve of the metals, that the product of the atomic weight and specific heat, in other words, the so-called atomic heat, had the same value, about 6.5, for all elements. Later observers have remarked striking departures from this law, and a comparison which H. F. Weber makes in a recent paper of the numbers obtained by Regnault, de la Rive, Kopp, and Wüllner, as representing the specific heat of carbon, clearly demonstrates that the different allotropic modifications of this element have very different specific heats, no one of which obeys Dulong and Petit's law, while the values assigned by these physicists to the specific heat of any one modification greatly differ. This he attributes to the fact that the specific heat of carbon in all its modifications varies with the temperature in a degree that would scarcely be supposed. By experimenting on two large diamonds he finds that the specific heat of carbon increases with the temperature to a degree surpassing any other substance, the specific heat of diamond being trebled by a rise of temperature from 0° to 200° C. The research was conducted in the physical laboratory of Professor Helmholtz, in Berlin.

FORMATION OF ACETYLEN BY ELECTRICITY.

DR. BERTHELOT.—The author states that he also obtained this body by applying Houzeau's apparatus for making ozone, passing the electric current through hydrogen saturated with vapors of hydrocarbons; but the quantity of acetylen thus formed is very small, and the author ascribes this to the fact that the electric discharge attended with sparks has a far higher temperature than the dark (non-luminous) discharge, and that, while acetylen is not decomposed by high temperature, ozone can not be formed under the latter condition.

NEW BLACK COLOR.

MM. LE BEL AND A. MUNTZ.—The authors have extracted from bitumen (native, as well as that obtained from tar) a black-colored substance, insoluble in alcohol and ether, soluble in sulphide of carbon and chloroform, and fusing—without volatilizing—at between 130° and 145°. This substance, which possesses very great coloring power, has been called asphaltene, and was found to consist chiefly of carbon and hydrogen. From an Egyptian bitumen the authors also obtained a similar body, but this was found to contain more oxygen, and, moreover, a notably large proportion of ash.

LIQUID CARBONIC ACID.

L. CAILLETET.—After briefly referring to Thilorier's researches on the liquefied carbonic acid gas, (which boils at 78° at atmospheric pressure,) the author describes his apparatus for experimenting with this fluid, which is colorless, very mobile, and a non-conductor of electricity; it neither dissolves common salt, sulphate of soda, chloride of calcium, nor carbonate of potassa, which is converted into bicarbonate insoluble in the fluid; carbonate of lime, either in the form of Iceland-spar or chalk, is not dissolved by this fluid, even under a pressure of 130 atmospheres, (1950 lbs. to the square inch.) Sulphur and phosphorus are insoluble in liquefied carbonic acid, but iodine is somewhat soluble therein; water scarcely dissolves the fluid, but ether and petroleum oil dissolve it readily, and sulphide of carbon dissolves it to some extent. Fatty oils are somewhat soluble in the liquefied carbonic acid, but stearine and paraffin are insoluble therein.

NEW EXPLOSIVE.

M. VIOLETTE.—The author, while heating a mixture of nitrate of potassa and acetate of soda in a small glass flask, was seriously injured by a sudden and violent explosion of the substances he operated upon. This accident gave rise to further investigation, the result of which is that a mixture of 100 parts of nitrate of potassa and 60 of acetate of soda, when heated and fused at about 300°, does not explode, and may even, after cooling, be pulverized and granulated; but if the salts are heated to 350°, or ignited by means of red-hot iron, a violent explosion instantly takes place. When either the nitrate or acetate is in excess of the quantity mentioned, the mixture only burns as dry wood would do.

FALL OF AEROLITES IN FRANCE.

A METEORITE fell in a field near Lancé, in July, and passed a metre and a half through the light soil into a bed of marl. It weighs 47 kilogrammes; some fragments separated by the fall were found near it. M. Daubrée records the more recent discovery of a second meteorite at Pont-Loisel, 12 kilometres south-east of Lancé. The line joining the two localities coincides with the direction of the trajectory of the meteors, and the Pont-Loisel stone, though much smaller, (it weighs 250 grammes,) bears the closest resemblance as regards mineral characters to the Lancé stone. The smaller stone fell first—a circumstance observed in former showers—and penetrated the soil to a depth of only half a metre.

CHARCOAL AND ORGANIC NITROGEN.

By E. C. STANFORD.—The author, in 1869, proposed a method of mixing excreta, fish offal, and other offensive matter, with charcoal, so as to deodorize them, and when dry to heat the product in retorts, thus obtaining the whole of the nitrogen as ammonia. Experiments were made to ascertain the truth of the current opinion that nitrogenous matters in contact with charcoal become oxidized, giving rise to nitric acid, which would of course render the process valueless. For this purpose mixtures of excreta and decaying animal matter with three different varieties of charcoal were prepared, and examined at different intervals during twenty-one months, but no nitric acid could be detected. The author therefore infers that charcoal mixed with nitrogenous organic matter acts simply as a dryer, and not as an oxidizing agent, and that for all practical purposes there is but little loss of nitrogen in such mixtures.

ABIETENE, A NEW HYDROCARBON.

W. WENZELL.—This hydrocarbon is the product of distillation of the terebinthinate exudation of a coniferous tree indigenous to California, viz., the *Pinus sabiniana*, a tree met with in the dry sides of the foot-hills of the Sierra Nevada mountains, and locally known as the nut-pine or digger-pine, owing to the edible quality of its fruit. A gum-resin, or rather balsam, is obtained from this tree by incisions made in its wood, and the balsam submitted to distillation almost immediately after having been collected, owing to the great volatility of the hydrocarbon, (or essential oil, because abietene really stands in the same relation to the balsam alluded to as oil of turpentine stands to the exudation derived from other *Pinus* species.) The crude oil, as usually met with for sale at San Francisco, is a colorless limpid fluid, requiring only to be redistilled to obtain it quite pure. The commercial article is used under different names—abietine, erasine, theoline, etc.—for the removal of grease and paint from clothing and woven fabrics, and likewise as an efficient substitute for petroleum-benzine. Pure abietene (the commercial article having been ascertained by the author to be a homogeneous liquid) is a colorless fluid, exhibiting a strongly penetrating odor bearing some resemblance to oil of oranges; sp. gr. at 16.5°=0.694; it is very volatile, highly combustible, burning with a brilliant white smokeless flame, almost insoluble in water, and soluble in 5 parts of alcohol at 95 per cent. Abietene is not acted upon by dry hydrochloric acid gas nor by nitric

acid (sp. gr.—1.43) in the cold, but heat being applied a slight reaction took place; neither concentrated sulphuric acid nor potassium act upon this hydrocarbon; when treated with chlorine, abietene is converted into fluid of the consistency of glycerine, insoluble in water, colorless, soluble in warm alcohol, and having a sp. gr.—1.666. Abietene readily dissolves iodine and bromine, and is a powerful solvent for fixed and volatile oils, castor oil excepted, and also Peru balsam and Canada balsam; castor oil is absolutely insoluble in abietene, while, curiously enough, the last-named substance is dissolved by castor oil to some extent. When burned in an ordinary spirit-lamp (such as are used in chemical laboratories) with not too large a flame, a brilliant white light is obtained without smoking. The vapor of abietene is a powerful anæsthetic when inhaled, and it has been used with success as an insecticide against moths, etc., when sprinkled in closed receptacles. The ultimate composition of abietene is not stated, but the author points out at some length the differences existing between abietene and terebene, (oil of turpentine.)
(60)

SOLVENTS FOR INDIGO.

By Dr. E. Jacobsen.—That aniline will dissolve indigo has been known several years, from my own experiments; but an equally good solvent for indigo is nitrobenzol, which, when heated with indigo, is colored a deep violet-blue, and on cooling deposits flaky crystals, and then appears dark red, probably from red indigo.

In greater or less quantities, the following substances dissolve indigo at their boiling-points:

Castor-oil, acetone, hydrate of chloral, camphor, oil of turpentine, balsam of copaiba, cedar-oil, (oil of juniper virgin,) amylic alcohol, oil of lavender, white bees-wax, Japanese vegetable wax, and Carnabba wax, (from this last small flaky crystals precipitate.)

The higher the boiling-point of the solvent, the redder is the appearance of the solution; so that bodies like acetone, amylic alcohol, and hydrate of chloral give a clear blue; castor-oil, cedar-oil, etc., a violet-blue, and the different kinds of wax a purple-red solution. If kept for a short time at the boiling-point with white wax, the color changes from scarlet to orange, and at last to a brown. The indigo is reduced by the formation of acrolein, and the solution retains its brown color even on the addition of gasoline.

If powdered indigo is added to melting picric acid, the former will be decomposed with deflagration. (23)

SAFFRANINE.—A NEW COLOR.

C. MÈNE.—Two parts of nitrite of aniline and 1 part of arsenic acid are heated together for five minutes to from 80° to 120°; the contents of the vessel in which this operation takes place are poured into boiling water, and the fluid neutralized with lime. The liquid, which turns a beautifully red color, is filtered through flannel, and the filtrate is next added to chloride of sodium in the proportion of five times the quantity of the nitrite of aniline used. The result is the precipitation of the new coloring matter, which is named saffranine, collected on a filter, and next submitted to pressure to remove water. Saffranine is used instead of safflower for dyeing wool and silk.

FORMATION OF OZONE.

DR. PINCUS.—The author states that, if perfectly pure dried hydrogen gas is caused to burn in a very small flame from a jet ending in a very fine point, the smell of ozone is very distinctly perceived, and it becomes more conspicuous if a dry and clean beaker-glass is held over the flame. When, by the aid of a properly contrived apparatus, the combustion takes place in pure oxygen, the same phenomenon is observed.

OZONE IN WATER.

BY L. CARUS.—Ozone has generally been considered insoluble in water. Meanwhile M. Soret has announced its absorption by that liquid; yet hitherto nothing positive is known on the subject.

It is easy to ascertain that water into which ozonized air or oxygen has been made to pass exhibits all its reactions; it decomposes iodide of potassium, decolors indigo and the sunflower, colors blue the tincture of guaiacum, transforms the protoxides of thallium, manganese, and lead into peroxides; by its action on silver one sometimes even succeeds in determining the formation of the peroxide of that metal. The author has, besides, proved that this water contains neither oxygenated water nor nitrous acid, either free or combined with ammonia, the presence of which might have explained at least a part of these reactions.

The power of absorption of ozone in water can not be determined with precision, because we can only operate on mixtures in which that gas is only in a very small and never very constant proportion.

In his experiments, the author produced ozone by Soret's method—that is to say, by electrolysis of sulphuric acid spread out and kept at the temperature of zero C.

In these conditions the proportion of ozone in the gas, determined by the decomposition of iodide of potassium, was found in two trials to be 0.93 and 1.21 volume per cent, supposing this gas to have a density equal to $\frac{3}{2}$ of that of oxygen.

The gas was caused to pass during from two to three hours into water kept between 2° and 4°; it was then submitted to analysis, and was found to contain per litre, in three experiments:

0.0109 gramme of ozone, or 5.11 cub. centims.
0.0094 " " 4.24 "
0.0083 " " 3.86 "

The author likewise analyzed the ozonized water supplied by the works of MM. Krebs, Kroll & Co., of Berlin, for medical uses. He found in it from 4.06 to 4.45 cubic centims. of ozone per litre; it, too, contained neither oxygenated water nor nitrous or nitric acid.

A NEW EXPLOSIVE.

A NEW explosive material and process for manufacturing the same, described by J. B. Muschamp, consists in first thoroughly extracting or neutralizing the sap and mineral salts contained in wood fibre by boiling it in a strong solution of caustic soda under pressure, then washing it, next reducing it to a proper length by a beater, and then drying it by a slow heat. The fibrous pulp thus produced is steeped for thirty hours in a bath of a solution of one part of nitrous or nitric acid with two parts, by volume, of sulphuric acid. It is then washed to remove the free acids, and steeped for several hours in any suitable alkaline solution, and again washed in water and dried. By this process a powerful explosive is produced, suitable for shells, torpedoes, blasting, etc., but by dipping a second charge of fibre in the same bath a weaker one is made which may be used for ordinary military or sporting purposes; and by introducing a third charge a still weaker one may be obtained.

TREATING HYDROCARBONS.

IT has been suggested by James Young that much of the impurities in hydrocarbons may be removed by treating them with hydrochloric or muriatic acid. The acid in the gaseous form should be passed through a pipe dipping into the oil, (or if the liquid acid is used it should be heated,) until the oil has taken up all the acid that it can, which will be known by the gas rising through the oil in bubbles. The impurities will be precipitated by the acid, and the clear oil may then be drawn off.

INSTANTANEOUS OXIDATION OF ALCOHOL.

By M. A. Houzeau.—Here is a simple example of the direct conversion of alcohol into acetic acid and aldehyde, without the coöperation of any other agent than oxygen modified by electricity.

If, into a bottle of half a litre capacity, filled with concentrated moist ozone obtained by means of one of my single or double-acting ozonizers, about 10 cubic centims. of absolute or hydrated alcohol be poured, a strong agitation of the bottle for a few seconds is sufficient to cause the neutral and almost inodorous alcohol to manifest a strong acid reaction with litmus-paper, due to the acetic acid formed,* and it exhales an odor of aldehyde, the presence of which is demonstrated by the reducing action of the liquor upon an ammoniacal salt of silver. But the most curious fact of the experiment is the simultaneous formation of relatively considerable quantities of oxygenated water; a few cubic centims. of the alcoholic liquor turn the mixture of chromic acid and ether deep blue.

On operating in like manner with ordinary oxygen, (that is, before the gas has undergone the obscure electrification,) nothing similar is observed. Even after twenty-four hours of contact the alcohol remained neutral, inodorous, and without action upon either the salt of silver or chromic acid.

Ether, in the same circumstances, undergoes from concentrated ozone an analogous and still more rapid oxidation, attended by the production of oxygenated water.

I can not too strongly advise chemists who make use of concentrated ozone to do so with the utmost caution; breathed, even in very small quantity, it suddenly occasions inflammation of the mucous membranes, which I have known to bring spitting of blood. (4)

SPECIFIC HEAT OF CARBON.

Dr. H. F. Weber, after careful experiment, finds that the law deduced by Dulong and Petit, to the effect that the product of atomic weight and specific heat have the same value for all elements, does not apply to carbon. He finds that a closer investigation has completely verified this conjecture. The specific heat of carbon increases with the temperature, and more considerably than that of any other substance; the specific heat of the diamond is tripled when the temperature is raised from 0° to 200°.

* After the action of ozone, alcohol saturated with lime-water and evaporated to dryness leaves a residuum which liberates acetic acid on contact with diluted sulphuric acid.

GLUCOSE.

THE following process for extracting syrup from corn, wheat, potatoes, or other substances from which starch can be made is described by William H. Keyt: The starch is first made by steeping the grain for seven days in warm water changed each day, then grinding it in water, and washing out the enamel, gluten, and other light matter. The starch is then agitated in a wooden vessel, and incorporated with about ten gallons of pure water at a temperature of 180° F. with each hundred pounds of starch. It is now ready for the converting tub, into which is put ten gallons of water and one and a quarter pounds of sulphuric acid for each hundred pounds of convertible matter. This solution is then brought to the boiling point, and the prepared starch run in gradually so as to keep the whole boiling, which is continued until the starch is converted into saccharine, and for two hours thereafter, until the vegetable properties are overcome. The sweet water is now run into another vessel and sulphate of lime added to neutralize the acid, after which it is run into a third vessel to precipitate the lime and other matter, and kept at a heat of 180° F. by a steam coil, to promote the precipitation. It is then boiled and filtered, and again boiled and filtered through bone-black, and again boiled, to increase its density.

NEW PRODUCT OF ALDEHYDE.

DR. WURTZ.—When a mixture of water, aldehyde, and hydrochloric acid is left to itself for a fortnight, next saturated with carbonate of soda, then well shaken up with ether, there is obtained, by the evaporation of the latter, a viscous thick mass, which is purified by distillation *in vacuo*, when the substance comes over at between 95° and 105°; this body is so viscous that the vessel in which it is contained may be inverted without the substance flowing out. This body has a high refractive power, is soluble in water, alcohol, and ether, and its simplest formula is $C_4H_8O_2$. The further investigation of this compound proves it to act as an aldehyde as well as an alcohol; it reduces nitrate of silver, forming a metallic mirror on glass, and combines with acetic acid, yielding a liquid acetate, which may be distilled *in vacuo* between 90° and 95°.

RAMIE PYROXYLINE.—According to a statement of Messrs. Deitz & Wayne, if the fibre of ramie (*Bochmeria Nivea*) be treated in the same manner as cotton to make pyroxyline, a much smaller quantity of solvent is required to turn it into collodion, and a superior article is produced.

THE METAL HYDRIUM.

IT is now just thirty years ago that the great French chemist Dumas announced, at the termination of one of his lectures on hydrogen, at the Sorbonne, Paris, the following views, then startlingly new and laughed at by many, but now commencing to be appreciated and adopted: "Whatever it may cost me, gentlemen, in the estimation of my colleagues, in giving a new opinion, I ought to express it fully. We ought no longer to consider hydrogen as a metalloid, or as merely approaching to a metal in any form; it ought to be classed by the side of metals or among metals. *It is a gaseous metal, even as mercury is a liquid metal.* If we suppose that it were impossible to liquefy the vapor of mercury, and consider that it is colorless, inodorous, and transparent as hydrogen, we shall have a correct idea of the views I wish to establish. By degrees you will learn to appreciate the correctness of this new theory when, for instance, you study the different compound bodies of which hydrogen is a counterpart. The *ensemble* of the properties approaches, in fact, to mercury and potassium."

Some German authors have now adopted these views, and Hiller calls, therefore, the element H "hydrium," in order to be consistent with the rule accepted in regard to the metals which have no common names, as cadmium, aluminum, etc., and, according to Dumas's views, hydrogen gas is considered as the vapor of this metal, which, for its condensation into a liquid metal, requires a temperature far below any cold we have thus far been able to produce; and then, for the solidification into the ordinary metallic state, a further degree of cold, perhaps as far below the freezing point of mercury as this is below the melting point of potassium. In order to come to an approximate estimate of such a low temperature, we may consider that hydrogen when cooled contracts like other gases for every degree $\frac{1}{480}$ of the volume which it possesses at 32° Fah.; and, inversely, increases as much in volume by heating. It has been surmised by many physicists—among them Clerk Maxwell and Clausius—that as heat thus increases the elasticity of gases it is the absolute cause of that elasticity, or, in other words, that the cause of that elasticity is the molecular motion, which we call heat, associated with the molecules of the gas; and which, by their increase, cause more powerful impact on one another and on the walls of the vessels containing them, and so increase the pressure. Therefore, the absolute zero of temperature would be the absolute zero of gaseous tension, that is, the temperature at which the gas would cease to

have any elastic force, would exert no pressure, or have no molecular motion whatsoever. It would then cease to be a gas, as steam ceases to be a vapor when a sufficient amount of latent heat, that is, molecular motion, is withdrawn. As 1° Fah. added increases the elasticity of hydrogen by $\frac{1}{490}$ of its volume, and each degree withdrawn diminishes the volume by $\frac{1}{490}$, it is evident that, if this law holds at all temperatures, there is no further reduction possible at 490° below 32°, and hence no more heat could be extracted; therefore the volume of the gas would cease to exist. Hence, if we withdraw heat until we reach —458° Fah., we should arrive at the absolute zero, at which all hydrogen would become lifeless and inert and incapable of responding to or assimilating any form of motion, which, under other circumstances, would influence its molecules. Other gases would probably liquefy or solidify before that point was reached; but hydrogen, being evidently the most volatile of all, would be the last to lose its gaseous condition, and be compelled to liquefy or solidify; it would then be chemically as inert as two pieces of solid metal, which are mutually inert in regard to one another. In short, chemically speaking, hydrogen would have the property of a solid metal; and, physically speaking, as there is no motion called latent heat of fusion or evaporation, there could be no cause for its liquidity of gaseous condition, and it could be in no other condition than that of a solid. These are the legitimate consequences of the modern theory in regard to heat being a mode of motion. (83)

STEELING IRON.

CHARLES M. NES proposes to case-harden or steelify either wrought or cast-iron articles by immersing them until they reach a white heat in a bath of melted codorus ore, either alone or combined with other ingredients, as rolling-mill cinder or silex. When the iron articles are sufficiently heated they are taken out, and if required to be very hard, are chilled in water, but if soft metal is wanted, are gradually cooled.

PUDDLING-FURNACE.

AN improvement on the rotary puddling-furnace suggested by J. Davies consists in forming in one part thereof a flat table to be used in puddling balls as in the ordinary stationary puddling-furnaces, and an aperture in the side through which the workmen may operate the iron on the table.

THE LAST NEW METAL, INDIUM.

By Prof. W. Odling.—Indium was first recognized in 1863, by Drs. Reich and Richter, in the zinc blende of Freiberg, in Saxony, and by reason of the very characteristic spectrum afforded—consisting of two bright blue or indigo bands; the brightest of them somewhat more refrangible than the blue line of strontium, and the other of them somewhat less refrangible than the indigo line of potassium. Its chief source is metallic zinc; that of Freiberg, smelted from the ore in which indium was first discovered, containing very nearly one half part of indium per 1000 parts of zinc. When zinc containing indium is dissolved not quite completely in dilute sulphuric or muriatic acid, the whole of the indium originally present in the zinc is left in the black spongy or flocculent residue of undissolved metal, with which every one who has prepared hydrogen gas by means of zinc and acid is so well acquainted. Besides some zinc, this black residue is found to contain lead, cadmium, iron, and arsenic, less frequently copper and thallium, and in some cases, as that of the Freiberg zinc, a small proportion of indium. From the solution of this residue in nitric acid the indium is separated by ordinary analytical processes, based chiefly on the precipitability of its sulphide by sulphureted hydrogen from solutions acidulated only with acetic acid; and on the precipitability of its hydrate both by ammonia and carbonate of barium. From its soluble salts, metallic indium is readily thrown down in the spongy state by means of zinc. The washed sponge of metal is then pressed together between filtering paper, by aid of a screw-press, and finally melted under a flux of cyanide of potassium.

Thus obtained, indium is a metal of an almost silver-white color, apt to become faintly bismuth-tinted. It tarnishes slowly on exposure to air, and thereby acquires very much the appearance of ordinary lead. Like lead, it is compact and seemingly devoid of crystalline structure. Moreover, like lead and thallium, it is exceedingly soft, and readily capable of furnishing wire, by the process of "squirring," or forcing. The specific gravity of indium, or 7.4, is very close to that of tin, or 7.2; and much above that of aluminum, 2.6, and below that of lead, 11.4, and that of thallium, 11.9. In the lowness of its melting-point, viz., 176° C., indium occupies an extreme position among the metals permanent in the air; the next most fusible of these metals, viz., tin and cadmium, melting at 228°, bismuth at 264°, thallium at 294°, and lead at 235°. Though so readily fusible, indium is not an especially volatile me-

tal. It is appreciably less volatile than the zinc in which it occurs, and far less volatile than cadmium. Heated as far as practicable in a glass tube, it is incapable of being raised to a temperature sufficiently high to allow of its being vaporized, even in a current of hydrogen.

Indium resists oxidation up to a temperature somewhat beyond its melting-point, but at much higher temperature it oxidizes freely; and at a red heat it takes fire in the air, burning with a characteristic blue flame and abundant brownish smoke. It is readily attacked by nitric acid, and by strong sulphuric and muriatic acids. In diluted sulphuric and muriatic acids, however, it dissolves but slowly, with evolution of hydrogen. Oxide of indium is a pale-yellow powder, becoming darker when heated, and dissolving in acids with evolution of heat. The hydrated oxide is thrown down from indium solutions by ammonia as a white, gelatinous, alumina-like precipitate, drying up into a horny mass. The sulphide is thrown down by sulphureted hydrogen as an orange-yellow precipitate, insoluble in acetic, but soluble in mineral acids. The hydrate and sulphide of indium, in their relations to fixed alkali solutions more particularly, seem to manifest a feebly-marked acidulous character. Chloride of indium, obtained by combustion of the metal in chlorine gas, occurs as a white micaceous sublimate, and is volatile at a red heat without previous fusion. The chloride itself undergoes decomposition when heated in free air, and the solution of the chloride upon brisk evaporation, with formation in both cases of an oxychloride. The atomic weight of indium is 113.5; specific heat, 0.0569; atomic heat, 1.05.

STAMPING SHEET ZINC.

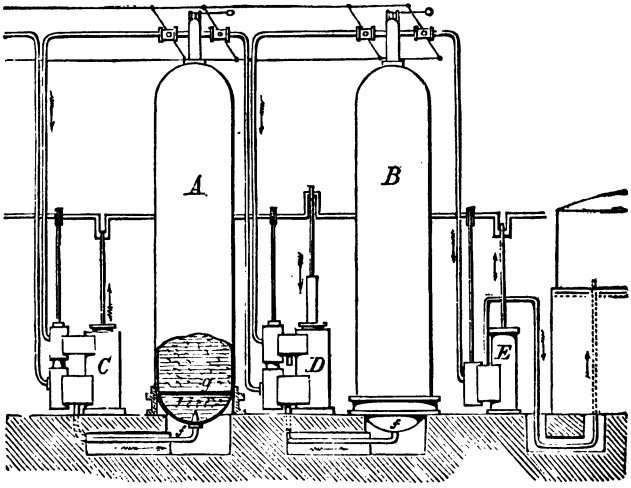
IN stamping sheet zinc in dies much waste occurs from the small difference between the melting point and the temperature at which sheet zinc should be stamped to get the best effect. To obviate this waste, A. T. Perkins heats the zinc by dipping in oil of the proper temperature. In addition to the saving of waste of zinc, the oil has a good effect on the dies also.

EFFECT OF COLD UPON CAST-IRON.

H. COCK.—The author relates that the cast-iron framework of a 12-horse horizontal high-pressure steam-engine, employed at the printing works of MM. Renou and Maulde, (Paris,) after having been exposed for some hours to a temperature of —15° suddenly snapped to pieces in three different places when the engine-driver attempted to start the engine very cautiously and at slow speed.

MALLET'S METHOD FOR OXYGEN.

THIS method is based upon the property of water to retain the oxygen of the air in preference to the nitrogen. Atmospheric air, as well known, is composed of 20.55 parts of oxygen and 78.16 parts of nitrogen, by volume, the remainder being carbonic acid and vapor of water. The air dissolved by rain-water of a temperature of 50° Fah.



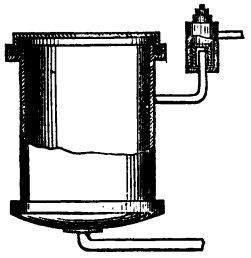
has been found to consist of 33.76 parts oxygen, 64.47 parts nitrogen, and 1.77 parts carbonic acid, by volume, showing thus an increase of 13.21 parts oxygen, and a decrease of 13.69 parts of nitrogen. One quart of water, according to Dalton, is capable of dissolving 2.44 cubic inches of air. This dissolving action of water is correspondingly increased by pressure, and Mallet has made use of it in the following manner and by the apparatus represented in our engravings. There is a series of chambers A B, eight in number, but only two are here shown, consisting of strong sheet-iron, almost entirely filled with water. There is also a series of double-acting air-compression pumps C D E, used in connection with the chambers as shown. The pistons and slide-valves of these pumps are all moved by the same shaft; the arrangement and operation of the mechanism being such that the air is passed through the water of the cylinders, and its oxygen is absorbed by the water. By a

change of the valves a suction is then produced in the cylinders whereby the oxygen contained in the water is drawn out and conveyed into the gasometer; air is then again passed into the water, its oxygen absorbed, and so on continuously. The arrangement of the mechanism is such that while the oxygen is being absorbed by the water in one cylinder it is being drawn off from the adjoining cylinder.

To the last chamber a pump is attached for the purpose of drawing the oxygen, now almost pure, into the gasholder, in which it is retained for use. The air, after having passed through eight chambers, consists of 97.3 volumes oxygen and 2.7 volumes nitrogen, the presence of this amount of the latter gas for most technical purposes being quite unimportant. The machine described has been in use in Frankfort-on-the-Main for some time past.

UTILIZING TIN SCRAPS.

PROFESSOR CHARLES A. SEELEY, of New-York, is the author of a new and simple method of utilizing the tin and iron of tin scraps, which promises to be of much value in the arts.



The scraps are placed within a suitable tank or holder, the cover of which is provided with a water seal in the usual manner. Chlorine gas is now admitted through the inlet pipe at the upper part of the holder, and allowed to remain in contact with the scraps until all the tin has been dissolved; air is then admitted through the inlet pipe which expels the gas and vapor, through the exit pipe at the bottom, into a condenser, and the resulting liquid, bichloride of tin, is then drawn off, and soon transformed into a merchantable article. The iron is then removed and delivered to the iron-workers, by whom the most superior qualities of bars are produced. This is a very economical and effective process.

GALVANIZED IRON.

THE bath of metal into which iron is dipped to coat it with zinc usually contains at its bottom a thin layer of lead to receive the dross from the zinc by the heat necessary to keep the latter fluid. As a large quantity of zinc is kept heated, a corresponding amount of dross is formed, which settles down at the bottom of the zinc and above

the lead, and requires removing at certain periods by ladles which pass down through the fluid zinc. To obviate this, Grey & Lippincott propose to use a large body of lead supporting a thin layer of zinc—say about three inches deep. In this manner very little dross is formed, and the zinc may be used up and new added every day. If the articles dipped in the zinc pass through it into the lead no ill effect is produced, so that the zinc may nearly all be worked out.

GEISSLER'S BULBS FOR WASHING GASES.

By J. M. Merrick, B.S.C.—Some chemists may be glad to have the hint given them, that in laboratory operations on a small scale Geissler's potash bulbs make the most convenient possible apparatus for purifying and drying gas. For example, in Marsh's arsenic test, with two bulbs connected with each other and with the evolution flask by bits of rubber tubing (the first bulbs containing water, and the second sulphuric acid) we have as compact and convenient a piece of apparatus as can be devised.

HARDENING AND ANNEALING METALS.

To prevent oxidation during the process of hardening or annealing metals, as in making dies, imitation Russia iron, etc., J. M. Lauth proposes to inclose the articles to be treated in air-tight cases from which the air is to be exhausted, so that articles undergoing the process of annealing or hardening will be kept from contact with air during the operation. In hardening dies, etc., they should be placed in one end of a long box, which end should be heated, leaving the opposite end comparatively cool. When the dies are heated sufficiently, the cool end of the box should be submerged in the hardening solution, its covering opened, and the dies shot directly into it.

Chloralum.—John Gamgee suggests that chloralum may be made by mixing chloride of calcium and sulphate of aluminum. For producing chloralum powder, dried chloride of calcium, the sulphate of aluminum, and from fifty to seventy-five per cent of silica or sulphate of lime is mixed together and ground.

Cotton-Seed Oil.—In a process for making cotton-seed oil, suggested by W. M. Force, the seed is first hulled, and then exposed to currents of warm, dry air, to remove the moisture, which will allow of the seed being stored or transported without injury. When the oil is to be expressed, the meal is first moistened with water, then subjected to a mulling and heating operation, after which the mass is pressed in the usual manner.

ELECTRICITY, LIGHT, HEAT, SOUND.

THE HYDRO-TELEGRAPH CABLE.

M. FERDINAND TOMMASI, of Paris, has designed a new mode of trans-oceanic communication, which he terms the "Hydro-electric Submarine Cable." The author calls attention to the disadvantages attending the use of the ordinary cable—the principal defects being its rapid oxidation, the slowness of the signals, and the impossibility of sending simultaneous dispatches; and proposes to abandon the electric current, as a means of transmission, and simply employ it to actuate the manipulating and receiving apparatus. To carry out his plan he has devised arrangements, based on the following theory, which we give in his own words:—"Given, in effect, a tube filled with a liquid, and closed at either extremity by pistons of similar resisting power; if any propulsive force be applied to one of the two pistons so as to displace and drive forward a certain portion of liquid, (section or molecule,) the said force will transmit its impulse instantly, and a displacement will be propagated from point to point, through all the successive molecules or sections of liquid to the last, and finally act upon the piston at the opposite extremity from that from which it started; provided, however, that previously all extraneous circumstances capable of decreasing the effect of said force be absent, or in other words, provided that by the application of a force capable of causing the required displacement, there is produced in the liquid mass no reduction of volume."

The hydro-electric cable is composed of a suitable number of minute tubes of pure red copper, united in a bundle, covered with gutta-percha, above which is an envelope of layers of cork. The latter substance is solidly packed and firmly secured by a covering of strong yarns of tarred hemp applied in crossed spirals. The tubes have an interior diameter of from $\frac{1}{8}$ to $\frac{1}{12}$ of an inch, and are drawn in lengths varying from 800 to 1000 feet.

They are connected end to end by being screwed into small sleeves of copper, and afterward soldered. The construction of the cable is shown in Figs. 1 and 2. At A, Fig. 1, are the copper tubes, B is the gutta-percha, C the cork, and D the hemp covering. Fig. 2 is a transverse section of the same. As many dispatches can be sent or received simultaneously as there are couples of tubes in the cable ; consequently, in that represented in our engraving, two messages may be forwarded at once. The tubes are filled with distilled water, to which alcohol is added, all air being carefully removed from the liquid.

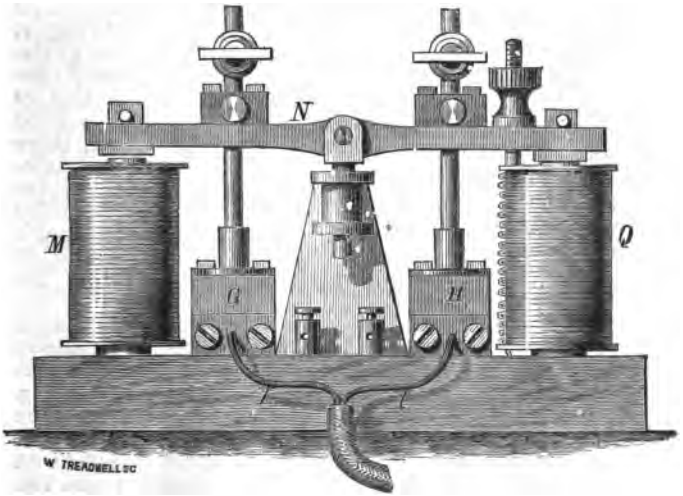
Fig. 1.

Fig. 2.

Each pair of tubes ends at one station in the *electro-manipulator*, Fig. 3, as shown at X and Y, and at the other, in the *relay apparatus*, Fig. 4, (similar letters.) In Fig. 3, at G and H are small vertical pumps ; in Fig. 4, I and J are also pumps, but are arranged horizontally. These are filled with the liquid, which consequently forms two fluid currents, of which one begins under the piston of vertical pump G, Fig. 3, and ends at the piston of horizontal pump I, Fig. 4, while the other passes similarly from the piston of pump H, Fig. 3, to the piston of pump J, Fig. 4.

By means of an ordinary Morse manipulator, shown at K in the plan-view, Fig. 6, (which will be hereafter more fully explained,) a current from the battery L, same figure, is passed into the electro-magnet M, (Fig. 3,) which attracts the lever N, forcing the piston of pump G to descend, and of course the piston of pump H to rise. The effect of this operation is to drive back the piston of pump I, (Fig. 4,) while that of pump J is carried forward. The piece O, (Fig. 4,) which is attached to both pistons, is therefore drawn to the right and caused to come in contact with the thumb-screw P. If, however, on the contrary, the current from the battery L be communicated to the electro-magnet Q, Fig. 3, the reverse of the operation above described takes place, and the piece O (Fig. 4) is caused to break contact with the thumb-screw P. The piece O and the screw P being the two poles of a local battery connected with any ordinary apparatus for receiving telegraphic signals, (Cadrau, Morse, Hughes, etc.,) it is

Fig. 3.



THE HYDRO-TELEGRAPH.—THE ELECTRO-MANIPULATOR.

evident that the current of this battery, alternately closed and interrupted, will set the machine in motion in the usual manner.

The two pump-cylinders, G and H, Figs. 3 and 6, are connected by two cocks S, and T, to the curved tube U, Fig. 6, from the centre of which leads a single pipe V to the hydraulic press W. The latter is shown in elevation in Fig. 5. When no signals are being transmitted, the cock at E in the last-mentioned figure, and the two others, S and T, are opened.

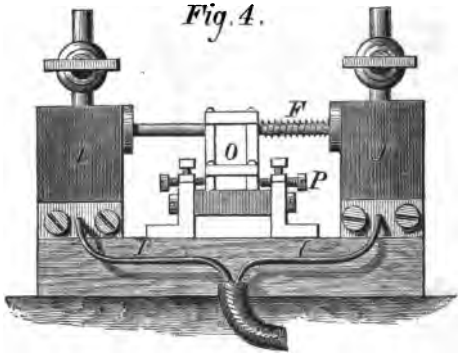
The weight with which the platform R, Fig. 5, is loaded, exercises an equal pressure on the liquid in all parts of the apparatus; and when by the downward effort of the piston the liquid is compressed or tubes expanded to the utmost extent, the communicated oscillation operated by the electro-manipulator at Fig. 5 will be transmitted immediately to the relay apparatus, whatever may be the diameter or length of the intermediate tubes. To produce this result, it is necessary to close the cocks E, S, and T, and to send successively to the electro-magnets M and Q, Fig. 3, a sufficiently strong current in order that each of said electro-magnets may in turn immediately attract the lever thus displacing the liquid column,

in spite of its resistance by the oscillations of the lever.

The piece O is moved a distance of but 1-10th of a millimeter; no more being necessary for a single contact and interruption. The pistons of pumps I and J, Fig. 4, have each a diameter of 6 millimeters; consequently the quantity of water displaced by each oscillation does not exceed 3 cubic millimeters in volume. The cocks S and T open, and the pressure of the liquid being equal on the pistons I and J, Fig. 4, the piece O remains stationary, and is at the same time kept from contact with the screw P by the spiral spring F.

The general arrangement of the apparatus may now be understood from the plan-view, Fig. 6. The lettered portions we have already referred to; those numbered are

Fig. 4.

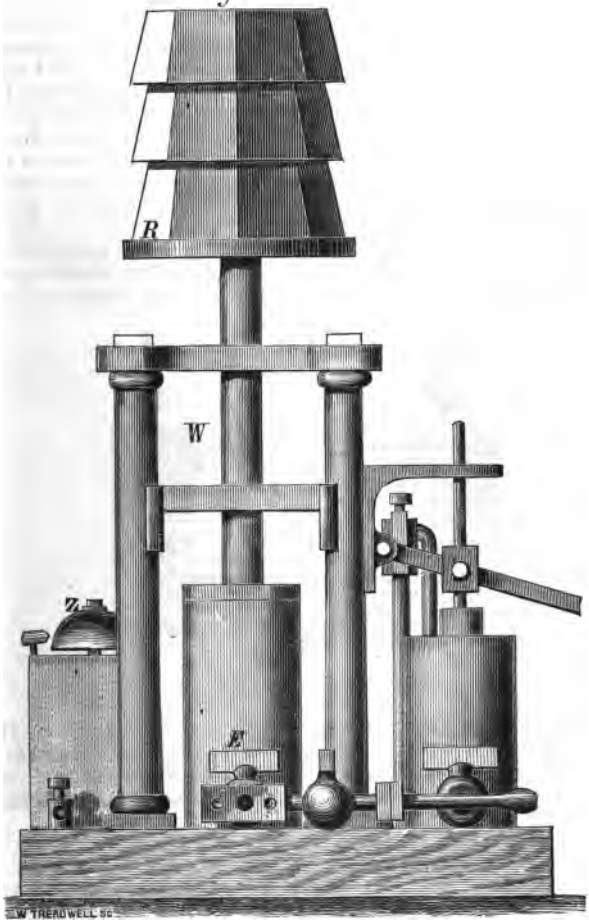


THE RELAY APPARATUS.

as follows: 1, the manipulator shown in Fig. 3; 2, the receptacle for water discharged from the hydraulic press; 3, battery; the space 4 represents the ocean between the two stations; 5 is the relay apparatus; 6, its batteries, and 7, the Morse receiver.

The hydraulic press, in addition to maintaining a constant pressure on the various parts, serves to compensate automatically for the variations of volume to which the liquid and apparatus are subjected by changes of temperature. The bell Z, Fig. 5, is used in connection with a self-acting arrangement to warn the operator when the platform arrives, at either end of its course, in order that by forcing in more liquid by means of the hand-pump seen at the right, or by permitting a portion to escape, he may return the platform to its proper position.

Fig. 5.

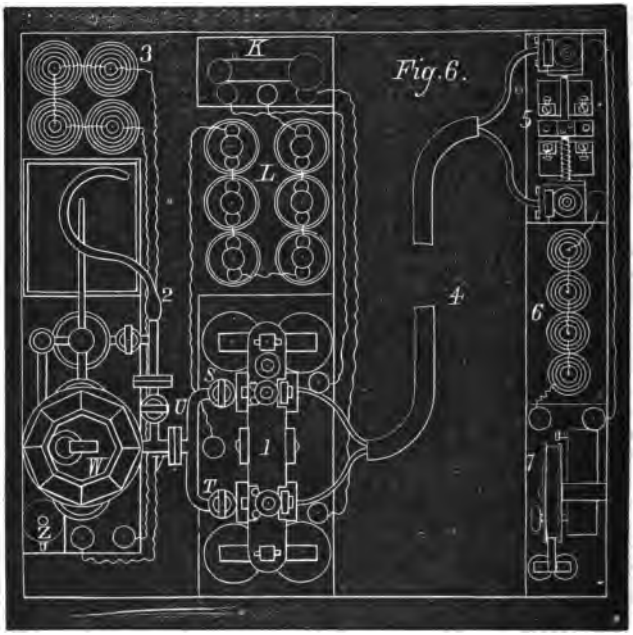


THE HYDRO-CABLE.—THE HYDRAULIC PRESS.

From exact calculations, the inventor states that the pressure exercised by the hydraulic press in order to obtain a velocity of twenty words per minute, does not exceed 240 atmospheres, 3600 lbs. per square inch, whether

tubes of an interior diameter of $\frac{1}{8}$ or $\frac{1}{12}$ of an inch be used, or whether the distance is from 250 miles in the first case to 2500 miles in the second.

M. Tommasi sums up the advantages of his invention as follows: 1st, as many simultaneous dispatches can be forwarded as there are couples of tubes, each couple being complete with the three machines above described; 2d, the rapidity of transmission may easily exceed 10 oscillations per second, which on the average represents twenty



THE HYDRO-TELEGRAPH CABLE.—GENERAL PLAN.

words per minute; 3d, no oxidate of the copper need be apprehended; 4th, any telegraphic system may be employed; 5th, the weight of the cable being but a few pounds to the mile, it may be easily laid or raised for repairs; 6th, at an expenditure of $600 per mile, a cable similar to the one above described may be constructed; 7th, and lastly, it may be used when required in the same manner as the ordinary cable, the copper tubes being isolated and fully capable of transmitting the electric current.

NEW GALVANIC BATTERY.

THE use of the metal chromium as the negative element in batteries has been suggested by Frederick E. Beardslee, who claims it to be the best metal ever used for this purpose. In practical use the metal may be mixed or combined with iron, carbon, etc., without material injury to its conducting and negative qualities; or it may be combined with platinum to give it ductility, or electrically deposited upon silver and other metals.

STEAM IN GALVANIC BATTERIES.

As a means of increasing the power of batteries, C. A. Linke suggests that a jet of steam be introduced beneath the fluid and in close proximity to the plates therein. By thus injecting steam into the battery, Mr. Linke states, its power may be considerably increased.

MEASURING TEMPERATURES BY ELECTRICITY.

BY C. WILLIAM SIEMENS, D.C.L., F.R.S., M.R.I.—The truth revealed to us by one of the younger branches of physical science, which has been cultivated and expounded nowhere more effectually than within these walls, has divested heat and electricity of their mysterious character, and has taught us to regard them simply as "modes of motion."

Light also has been shown to be identical in its nature with heat, and the only remaining physical agency, "chemical affinity," has been recognized as a lforce differing only in "quality of action" from the others. According to these views, force, in whichever type of action it presents itself, is as *indestructible as matter itself*, and is therefore capable of being *stored* up and *measured* with the same certainty of result. We have a unit of force or the foot-lb., and a unit of heat, or the heat necessary to raise the temperature of 1 lb. of water through 1° F., and it has been already proved that 772 units of force are the equivalent value of one unit of heat. Again, the chemical force residing in 1 lb. of pure coal is equal to about 14,000 heat units, or $14{,}000 \times 772 = 10{,}808{,}000$ ft.-lbs. $= 4825$ tons lifted 1 foot high.

Questions regarding the quantitative effects of heat present themselves, however, much less frequently for our consideration than questions regarding its *intensity*, upon which depends the nature of the phenomena surrounding us at every step, both in science and in ordinary life. The instrument at our command for determining moderate intensities or temperatures, the mercury thermometer, leaves little to be desired for ordinary use; but

when we ascend in the scale of intensity, we soon approach a point where mercury boils, and from that point upward we are left without a reliable guide. It is my purpose to present here an instrument by which I hope to fill up to some extent the existing gap. It is the result of occasional experimental research, spread over several years, and it aims at the accomplishment of a double purpose, that of measuring high temperatures, and of measuring with accuracy the temperatures of *inaccessible* or *distant* places.

The air-thermometer, Fig. 1, consists simply of a bulb of glass with a long tubular stem, open to the atmosphere at its extremity. If I heat the bulb (by dipping it, for instance, into boiling water) and put it into a holder, with the hollow stem reaching downward into a cup of mercury, the air within the bulb will no longer communicate directly with the atmosphere, because the mercury is interposed. If now I cool the air within the bulb, by the external application of iced water, its heat-motion will diminish, and its volume would be reduced proportionally, if the external atmosphere could enter freely to fill up the vacancy thus created. But inasmuch as the external air can not enter, a reduction of pressure will take place, which, according to the law of elasticity by Boyle, must be proportionate to the reduction of volume at constant pressure. The difference of pressure thus created between the bulb and the external atmosphere will be balanced by the column of mercury rising up into the tube, and the elevation to which the mercury attains is a true index of the temperature to which the air in the bulb had been previously heated. This is true with regard to all temperatures, from the lowest to the highest, and the instrument may be termed a universal thermometer. If the bulb could be cooled down to 273° C. below the zero-point, it would follow by the law of Charles, that the elastic pressure of air would be reduced to nothing; that is to say, the motion of the particles of air, which we call heat, would

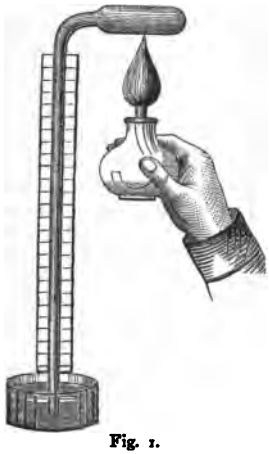


Fig. 1.
THE AIR-THERMOMETER.

have ceased, and we should have reached the point of absolute zero, a point which has been theoretically established also by other means. Practically, such an instrument would be most inconvenient.

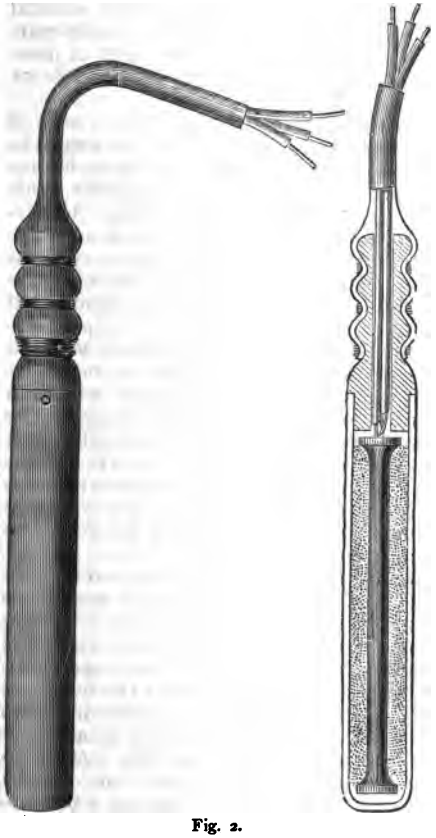


Fig. 2.
ELECTRIC PYROMETER.—UFLL SIZE.

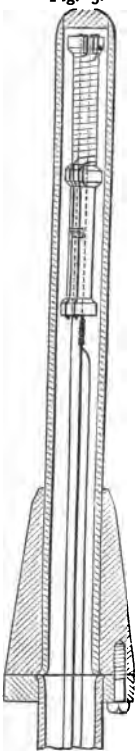
The new instrument presents many points of analogy with the air-thermometer, if we substitute "*electrical resistance in conductors*" for "*expansion of gases*"!

To show that the conductivity of platinum or other metal-wire is greatly influenced by its temperature, I pass a current through two branches of equal resistance, each comprising a free spiral wire of platinum and one of the coils of a galvanometer. The resistance of both circuits being the same, no deflection of the needle is observed on pressing the key, but on placing a spirit-lamp under one branch the resistance is increased, and the needle, influenced by the larger proportion of electricity passing through the cooler wire, is thrown to the right.

If, instead of using the open spirals, I were to wind thin insulated wire of any pure metal upon two small

cylindrical pieces of wood, and were to inclose the tiny spirals in small silver casings, as shown (in view and in section) by Fig. 2, taking care that the extremities of the spiral wires were soldered to thicker insulated wires, leading respectively to the battery and differential galvanometer before mentioned, it follows that no deflection of the needle ensues when both the protected and equal spirals are dropped into a jar containing iced water.

Fig. 3.



ELECTRIC PYROMETER.

If, however, one spiral be held in the hand, a deflection is at once visible. If I add warm water to the ice-water until the needle is once more at o, it is evident that the temperatures of the solution and of the hand are identical, and consequently a mercury thermometer placed in the water indicates the heat of the distant member. This arrangement may be used in physiological researches to enable the observer to read the temperature from time to time without disturbing the patient.

The same method is applicable for measuring the temperatures of distant or inaccessible places, such as the interior of stores or cargoes of materials liable to spontaneous combustion; of points elevated above the surface of the ground; or of great depths below for meteorological purposes; or for measuring the temperature of the sea continuously in attaching such a coil to the mariner's sounding-lead.

The error arising from the uncertainty of resistance of long leading wires is avoided by uniting three separate insulated leading wires into a cable by which the distant coil is connected with the measuring instrument. One galvanic circuit passes from the battery through one of the leading wires, through the distant spiral, and back again through the second leading wire to the differential galvanometer and the battery, and the second passes from the same battery through the near coil, and through the third leading wire up to the distant coil without traversing the same, and back again through the second leading wire to the galvanometer and battery. Thus both galvanic circuits comprise the leading wires up to the distant coil, and all variations of resistance by temperature to which the leading wires may

be subjected affect both sides of the balance equally. In constructing coils formeasuring deep-sea temperatures, a large quantity of insulated copper or iron wire is wound upon a metallic tube open at both ends to admit the sea-water freely, in order to impart its temperature to the innermost layers of the insulated wire. The coil of wire is protected externally by drawing a tube of vulcanized india-rubber over it, which in its turn is bound round by a close spiral layer of copper wire, whereby the sea-water is effectually excluded from the sensitive coil. By these arrangements, the temperature of distant or otherwise inaccessible places can be accurately ascertained; but the method is limited to the range of temperature which can be obtained and measured in the comparison bath.

In the construction of a pyrometer by electrical resistance, a metal must be used for wire capable of resisting intense heats, and must be insulated by a material not liable to be fused or rendered conductive by the highest temperatures. These various conditions are very fully realized by the arrangement represented on the diagram, Fig. 3.

Thin platinum wire is coiled upon a cylinder of hard-baked porcelain, upon the surface of which a double-threaded helical groove is formed for its reception, so as to prevent contact between the coils of wire. The porcelain cylinder is pierced twice longitudinally for the passage of two thick platinum leading wires, which are connected to the thin spiral wire at the end. In the upper portion of the porcelain cylinder the two spiral wires are formed into a longitudinal loop, and are connected crossways by means of a platinum binding-screw, which admits of being moved up or down for the purpose of adjustment of the electrical resistance at the zero of Centigrade scale. The porcelain cylinder is provided with projecting rims, which separate the spiral wire from the surrounding protecting tube of platinum, which is joined to a longer tube of wrought-iron, serving the purpose of a handle for moving the instrument. If the temperatures to be measured do not exceed a moderate white heat, or, say, 1300° C. = 2372° F., it suffices to make the lower protecting tube also of wrought-iron, to save expense. This lower portion only, up to the conical enlargement or boss of iron, is exposed to the heat to be measured. Three leading wires of insulated copper united into a light cable connect the pyrometer with the measuring instrument, which may be at a distance of some hundred yards from the same. They are connected

by means of binding-screws at the end of the tube to three thick platinum wires passing down the tube to the spiral of thin platinum wire. Here two of the leading wires are united, whereas the third traverses the spiral, and joins itself likewise to one of the two former, which forms the return-wire for the two electrical circuits.

It being found that the use of the delicate galvanometer in many localities was attended with practical difficulties, I have devised another instrument known as the "differential voltameter," which needs no careful adjustment or special skill in its manipulation, and is independent in its action from tremulous motion or from magnetic disturbances of moving masses of iron. The decomposition of water in a voltameter, expressed by the volumes of gases, is proportionate in the unit of time to the intensity of the decomposing current; according to Ohm's general law, the intensity is governed by the electro-motive force and inversely by the resistance; therefore the volume would give a correct measure of the resistance, if the electro-motive force and time were known and constant quantities.

It occurred to me, however, that these uncertain elements might be entirely eliminated in combining two similar voltameters in such a manner that the current of the same battery was divided between the two, the one branch comprising the unknown resistance to be measured, and the other a known and constant resistance.

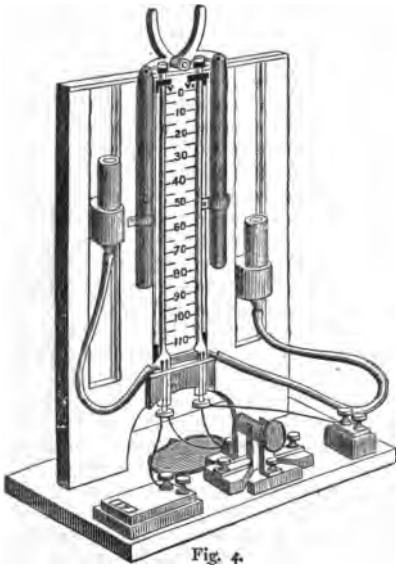


Fig. 4.

SIEMEN'S PYROMETER INDICATOR.

The mechanical arrangement of the instrument will be understood from the diagram, Fig. 4; and the whole arrangement of the pyrometer, with its leading wire and resistance meas-

urer, from the general view given in Fig. 5. The voltametric resistance measurer consists of two calibrated vertical tubes of glass of about 3 mm. diameter, which are fixed upon a scale showing arbitrary but equal divisions. The upper ends of the tubes are closed by small cushions of India-rubber pressed down upon the openings by means of weighted levers, whereas the lower portions of the tubes are widened out and closed by plugs of wood, through which the electrodes in the form of pointed platinum wires penetrate to the depth of about 25 mm. into the widened portions of the tubes. By a side-branch, the widened portion of each vertical tube communicates, by means of an India-rubber connecting-pipe, to a little glass reservoir containing acidulated water, and supported in a vertical slide. In raising the weighted cushions, closing the upper ends of the vertical tubes, and in adjusting the position of the small reservoirs, the acidulated water will rise in both tubes to the zero-line of the scale. In turning a button in front of the tubes, the battery current is passed through both pairs of electrodes, the one circuit comprising the permanent resistance, and the leading wires up to the pyrometer, and the other the leading wires and the pyrometer coil. If the resistance of the pyrometer coil should be equal to the permanent resistance, the volumes of gases in both voltameters would be equal, but as the resistances differ, so will the volumes. Necessary conditions are ; that both reservoirs are filled with the same standard solution of pure water with about 10 per cent of sulphuric acid, that all the electrodes are of the same form and size, and that their polarity is reversed frequently during the progress of each observation, in order to avoid unequal polarization. With these precautions, which involve no particular skill or knowledge of electrical observation on the part of the operator, very accurate results are obtained ; but in order not to incur considerable error of observation, it is advisable to continue the current, reversing the same say twice, until at least forty divisions of gases are produced in the least activated tube, which operation will occupy from two to three minutes ; if a battery of from 4 to 6 Daniell elements is employed. The volumes, being noted, after having allowed half a minute for the gases to collect after the current has ceased, the weighted cushions upon the tubes are raised, in order to allow the gases to escape, when the water-levels will immediately return to their zero position, to make ready for another observation. By inserting the observed values into formulas which may be deduced, the unknown resistance

can be easily calculated ; but, in order to facilitate the use of the instrument, I have prepared a table which gives at a glance the resistance due to any two observed volumes.

It now remains only to be shown what is the relation between the resistance and temperature in heating a platinum wire. The researches of Dr. Matthiesen, who

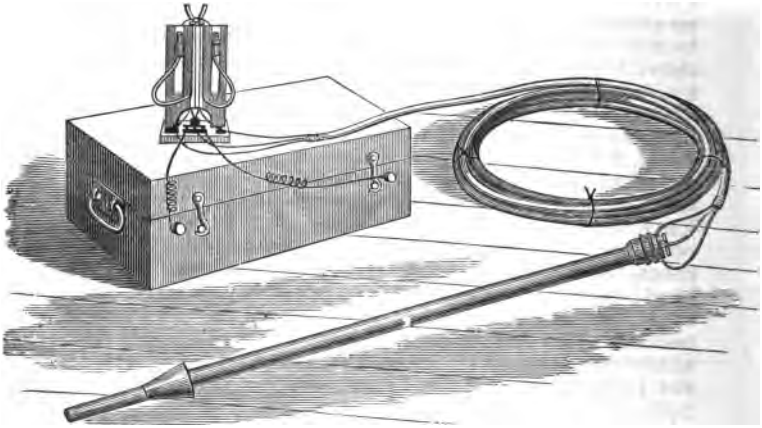


Fig. 5.
SIEMENS'S ELECTRIC PYROMETER.

has made the latest investigations on the effect of temperature upon electrical resistance, are restricted to the narrow range of temperatures between 0° and 100° C., nor do they comprise platinum.

It was necessary for my purpose to undertake a series of elaborate experiments with a view of finding a ratio of general application. Coils of thin wire, of platinum, iron, copper, and some other metals, were gradually heated and cooled in metallic chambers containing the bulbs of mercury thermometers, and for higher temperatures, of air thermometers, and the electrical resistances were carefully noted. The progressive increase of electrical resistance was thus compared directly with the increasing volume of a permanent gas (carefully dried) between the limits of zero and 470° C., and a ratio established, according to which the electrical resistance is a constant at the absolute zero, and progresses in a ratio represented graphically by a tipped-up parabola, approaching more and more toward a uniform ratio at elevated tempera-

tures. Although the comparison with the air-thermometer could only be carried up to 470° C., the general correctness of the ratio of increase just stated has been verified by indirect means in measuring progressive heats, and by comparison with the platinum ball pyrometer.

It is important to mention here that great care must be exercised in the selection of the platinum wire for the measuring spiral. It appears that the platinum prepared by the old welding process is purer and therefore better suited for electrical purposes than the metal consolidated by fusion in a Devill furnace.

The instrument which I have had the honor to bring before you this evening has already received several useful applications. Through its first application an important telegraph cable was saved from destruction through spontaneous generation of heat. Professor Bolzani, of Kasan, has made some interesting applications of it for recording the temperature at elevated points, and at points below the earth's surface. Mr. Lowthian Bell has used it in his well-known researches on blast-furnace economy; and at several iron-works pyrometer tubes are introduced into the heating stoves, and permanently connected with the office, where the heat of each stove can at all times be read off and recorded.

ELECTRICAL APPARATUS FOR THE PRODUCTION OF OZONE.

By Professor Arthur W. Wright.—Experiment has shown that, in the production of ozone by electricity, the maximum amount of oxygen is ozonized by the silent or glow discharge, and most of the forms of apparatus by which this is effected are contrivances by which oxygen is made to flow slowly through a space traversed by such a discharge.

The apparatus which I have employed, and which has afforded very satisfactory results, consists of a straight glass tube about 20 centimetres long and having an internal diameter of 2.5 centimetres, the two ends being stopped with corks covered on the inner side with a thin coating of cement to protect them from the action of the ozone. Through the axis of each cork is inserted a glass tube of about 5 mm. calibre, and 7 centimetres in length, having a branch tube inserted perpendicularly at the middle and long enough to permit a rubber tube to be slipped upon it. The outer ends of the tubes themselves are closely stopped with corks, through which are passed straight, thick copper wires carrying suitable terminals at

their inner ends, and bent into a ring at the others. They are fitted so as to make tight joints, but to allow of motion in order to vary the distance between their inner ends. One of these wires carries a small ball; the other terminates in a disk with rounded edge, set perpendicularly to the axis of the tube, and so large as to leave an annular space of some 2 or 3 millimetres breadth around it. The gas is admitted through one of the branch tubes and escapes from the other, after having passed through the whole length of the tube.

In using the apparatus, the wires must be connected with the poles of the machine in such a manner that the disk becomes the negative terminal, as this arrangement gives the greatest degree of expansion and diffuseness to the current. On turning the machine and adjusting the ball and disk to a proper distance, a nebulous aigrette surrounds the latter, quite filling the interval between it and the wall of the tube, while the part of the tube between the disk and ball is crowded with innumerable hazy streams converging upon the positive pole, or simply causing the latter to be covered with a faint glow. A current of air or oxygen sent into the tube must pass through this, and ozone is very rapidly produced, and in great quantity. The condensers are of course not used with the machine when this apparatus is employed.

Some experiments which were made with the apparatus will give an idea of its efficiency. 100 c.c. of water were placed in an upright tube or test-glass, and into it were put 20 drops of strong indigo solution, causing it to assume a deep blue tint. Air was driven through the ozonizing tube under a pressure of about 3 inches of water, and on issuing from it conveyed by a tube into the solution. When the electro-machine was put in operation, being turned with sufficient speed to give nearly its maximum effect, the solution completely lost its blue color in less than four minutes. Blue litmus solution under similar circumstances became pale pink, but required a considerably longer time for the change. With dry oxygen the effects were much more rapid and remarkable.

When oxygen is used, it is found that the electrodes must be separated to a much greater distance than is necessary for air, otherwise sparks pass and destroy a large proportion of the ozone already formed. With air, the direct spark in the apparatus could not be made to pass over an interval of more than 7 centimetres, but in oxygen they did not cease until the poles were separated

about 11·5 centimetres. When the tube was filled with air, and the poles were 7 or 8 centimetres apart, the discharge was of the silent kind, but on admitting oxygen, it immediately took the form of direct sparks. (7)

FLUORESCENCE.

AT a meeting of the American Institute, New-York, President Henry Morton, of the Stevens Institute of Technology, read a paper on "Fluorescence," or that action by which rays of the higher purple, or even invisible light, such as produce most strongly photographic action, excite in certain bodies lower rates of vibration, resulting in the emission of light, generally of a red, green, or clear blue color. This paper was illustrated by a number of striking experiments. Thus, a flask of solution of chlorophyl, (a green coloring-matter obtained from leaves,) which is of an olive-green color, being held in a beam of blue light proceeding from a "vertical lantern," appeared to be full of a blood-red liquid. Various solutions colorless in ordinary light were then shown to exhibit the brightest hues when illuminated by the violet rays of the lantern, or those obtained from the electrical discharge of the Professor's large coil in rarefied gases. The speaker then announced that in the course of the examination which he had been making of such substances, he had encountered one which he believed to be as yet unknown, and which possessed the property of developing light by fluorescence in a pre-eminent degree. This body was obtained from petroleum, and he would propose to take for it the name "Viridin." The word viridin had been already applied as a synonym for chlorophyl, but was now practically obsolete, and too appropriate to the present substance to be thrown away. A large drawing of a flower, with leaves painted seemingly in light umber tints, was then shown and illuminated by electric discharges, when it appeared of the most vivid green. The peculiar fluorescent spectrum of this body, and its relations to the spectra of other substances, was explained, and many other illustrations were exhibited.

NEW VOLTAIC ELEMENT.

BY M. J. MORIN.—This new element has for its object the complete avoidance of the inconvenience which results, in the ordinary sulphate of copper element, from the deposit of zinc either on the copper or the porous cell. It consists of a cylinder of copper, the interior of which is concentric with the cylinder of zinc; the annular space comprised between these two metallic surfaces is

divided into two equal parts by a cylinder of filter-paper. Ordinary sandstone is put between the interior surface of the copper and the paper diaphragm, and sublimed sulphur on the side of the zinc; the whole is plunged in a solution of sulphate of copper, which penetrates through the mass by means of the numerous minute orifices freely to the copper.

Some hundred elements prepared in this manner, and frequently in use, have been set up for more than twenty months, and the alteration which they have undergone shows that this is but half the time for which they may be worked; they have been perfectly closed during this time, and have neither been subjected to repair or inspection. (4)

PRINTING NEWSPAPERS BY ELECTRICITY.

THE idea of making stereotype plates in different cities by means of electric connections, so that newspapers may be printed simultaneously in various places, has been advanced by Merritt Gally, who proposes to use in each city where the paper is to be printed an automatic stereotyping or mould-forming machine, consisting of a suitable number of metallic strips, each of which has the letters of the alphabet, figures, points, etc., formed on it. These strips he intends to arrange by electric conductors so that a line of news will be formed by them which is impressed on a plastic substance secured to a drum or wheel. After the impression is taken the type-strips are arranged, by the same means, to form another line, the wheel moved around the depth of a line, and another impression is made in the mould, and the process continued until the plate or mould is filled, when the wheel is removed and another substituted. The mould thus made, when hardened, may be used for making a stereotype plate, or if the types have sunken faces, the inventor thinks it may be used as a stereotype itself.

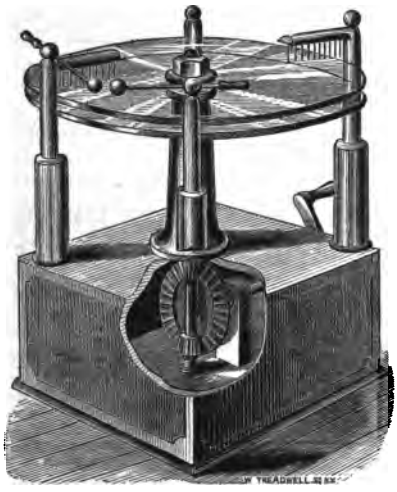
TELEGRAPHIC PAPER.

TELEGRAPHIC paper, as usually made with potassium and starch, is liable to stick together and scale off, and the marks thereon soon fade. To overcome these difficulties, George Little proposes to decrease the amount of starch, and states that the right proportions are: water, 192 parts; iodide of potassium, 48 parts; and starch, 4 parts. The waste-paper may be treated, to recover the potassium therefrom, by boiling in water and then squeezing the liquid out, from which the chemical may be recovered by evaporation or otherwise.

NEW HOLTZ ELECTRICAL MACHINE.

THE most recent improvement of Holtz for his electric machine is to employ two plain sheets of glass which are made to rotate in contrary directions. An improved plan to effect this rotation is suggested by Henry Turton, who describes it as follows:

The rotation of the glass disks in opposite directions is effected by means of a bevel-wheel inside the box, gearing with two pinions, the upper one of which is fast on a tube which runs in bearings in the wooden column to drive the lower disk, and the bottom pinion is keyed on the centre spindle, which turns inside the tube, and runs up to drive the top disk in the opposite direction to the lower one. The top disk has a hole in its centre, and is tightened by a nut compressing it between two plates lined with wash-leather; this is to allow it to be readily removed in order to clean the plates before use. The lower disk may be fastened with diamond or other cement to the metal plate underneath, which is soldered on the top of the tube. The closer the disks are together the better, and care should be taken to have every thing in balance, and running very true, otherwise a high velocity will cause a great deal of shake. At the corners of the box there are four insulating glass pillars supporting the armatures, which are also called combs, as they each have projecting arms carrying a number of needle-points directed toward the glass. The position of these combs, and their connection with each other, is of importance. Two of the combs are underneath the plates, and the comb-teeth point upward, nearly in contact with the glass. The other two combs are arranged above the plates, the teeth pointing down, as shown in the cut. The upper and lower combs must be electrically con-



nected, in alternate pairs, by conducting-wires, extending from one comb to the other. These connections practically reduce the arrangement to two independent armatures only. It is found advantageous to make the armature double—that is, with two combs, one above and the other below, though the machine will work with only one, as shown. The dischargers are rods sliding by preference in ball-sockets, and having insulating handles at one end, and discharging knobs at the other. To excite the machine it is only required to hold a sector of strongly electrified vulcanite, glass, paper, or resinous substance, immediately over one of the lower combs, and turn the handle a few times round; the sector may then be removed, as the machine will afterward multiply the charge, *ad libitum*, to the point of saturation, exhibiting a beautiful appearance in the dark. It is surprising what a torrent of loud-snapping sparks are produced, and with what rapidity a large Leyden battery may be charged. The only drawback to the working is its great sensitiveness to damp air, which, however, may to a great extent be mitigated by sprinkling a few drops of petroline under the disks, the vapor of which seems to hinder the deposition of moisture on the glass surfaces.

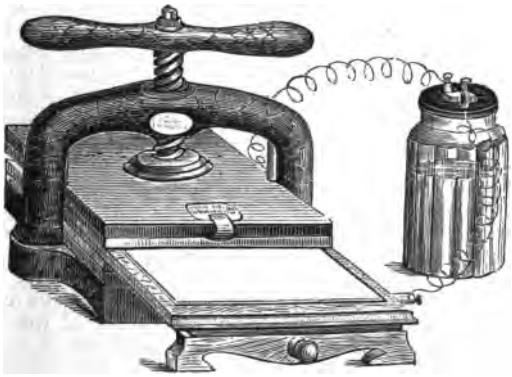
NEW GALVANIC BATTERY.

By using a concentrated aqueous solution of potassium permanganate, acidulated with sulphuric acid, in the place of nitric acid, in a Grove's battery, J. H. Koosen (*Pogg. Ann.* 144, 627) has produced an element of greater power, its electromotive force, according to numerous determinations, being at least double that of a Daniell. While the electromotive force of a Grove's element varies according to the strength of the nitric acid, that of the permanganate couple, the author finds, remains the same no matter what the concentration of the liquid: the introduction of a single drop of permanganate solution into the porous cell containing acidulated water at once develops the full force of the current; this of course subsides as rapidly, owing to the decomposition of the permanganate. It is well known that in Grove's battery, owing to the evolution of gas, there is a continuous movement of the liquid in the cell, constantly bringing fresh portions of acid to the surface of the platinum plate; when permanganate is used, the dissolved salt in immediate contact with the plate is soon exhausted, and owing to its small diffusive power a fresh supply is not immediately forthcoming, so that the strength of the current sinks rapidly; the slightest agitation, however, suffices to restore it to its original

strength. This difficulty the author overcomes by increasing the surface of the platinum plate, constructing it as follows: a number of strips of the same size are cut from very thin sheet platinum, slightly narrower than the diameter of the porous cell, and about four cm. shorter than the cell in length; these are placed one above the other and soldered together at either end with gold, at the middle of the narrow ends; a platinum wire, at least one mm. thick, is also soldered to one plate as pole wire; the several halves are then so bent apart as to form a cylindrical fan of platinum plates. By dispensing with a porous cell the internal resistance may be greatly lessened; in which case, in order to prevent contact between the platinum and zinc, a cylinder of coarse hair-cloth is loosely placed inside the zinc cylinder; on this rests the platinum electrode; the whole is charged with water and sulphuric acid, the permanganate (20 to 30 grm. in crystals) being placed in a platinum sieve with meshes not more than 1 mm. in diameter, resting on the zinc cylinder, but separated from it by the hair-cloth, which has therefore to be longer than the cylinder itself.

ELECTRICAL COPYING-PRESS.

THIS press, the invention of Signor Zuccato, of Padua, Italy, differs but little in appearance from an ordinary copying press, and that difference lies mainly in the con-



struction of the upper and lower beds or surfaces of the press, of which the former consists of a plate of copper, and the latter of a plate of copper tinned, both on mahogany beds—the upper one being attached by lugs or clips to the solid iron press-plate, and the lower being made to

slide out as shown. These plates are placed in the ordinary way in the circuit of a battery, so that, when brought into close proximity by the action of the screw, the circuit is completed and a current established over the whole of the surfaces.

But by the aid of an insulating medium—a varnish—applied to a steel plate and removable by the action of a "style" in writing, printing, drawing, etching, etc., the electric current is confined to those portions only which are so denuded of the insulating protection; and here it is made to leave record of its passage by its continued action on the steel plate and sheets of copying-paper specially prepared and damped with a solution of prussiate of potash. The electrolytic action causes the formation of the ferro-prussiate known as the "Prussian-blue," producing a perfect facsimile of the original manuscript or design wrought on the varnished surface of the plate.

The battery employed consists of a single cell, with zinc and carbon elements in an actuating solution of bichromate of potash and sulphuric acid; and its positive and negative poles are connected in the usual way by spiral coils of insulated wire, with the upper and lower beds of the copying-press. The movable steel plates, on which the writing, drawing, or other design to be copied is made, has to be thoroughly cleaned and well and evenly varnished; care also must be taken, by a firm, steady pressure on the style, effectually to remove the varnish, leaving the writing, printing, or other pattern in bright steel on a raised ground of varnish, affording perfect insulation everywhere else on the surface.

By placing the copying sheets, efficiently damped with the prussiate solution, in any number from one to five or six, one over the other, superimposed on the prepared plate, a corresponding number of copies can be obtained, and so on, almost *ad infinitum*. Thus any required number of copies can be produced with perfect facility and ease—all being facsimilies of the original. (74)

LIGHTNING-RODS.

By Henry Wilde.—I have recommended that in all cases where lightning conductors are attached to buildings fitted up with gas and water-pipes, the lower extremity of the lightning conductors should be bound in good metallic contact with one or other of such pipes outside the building. By attending to this precaution the disruptive discharge between the lightning conductor and the gas and water-pipes is prevented, and the fusible metal pipes in the interior of the building are placed out of the influence of the lightni g discharge.

Objections have been raised by some corporations to the establishment of metallic connection between lightning conductors and gas-mains, on the ground that damage might arise from ignition and explosion. These objections are most irrational, as gas will not ignite and explode unless mixed with atmospheric air, and the passage of lightning along continuous metallic conductors will not ignite gas even when mixed with air. Moreover in every case of the ignition of gas by lightning the discharge is actually transmitted along the mains, such objections notwithstanding. A grave responsibility therefore rests upon those who, after introducing a source of danger into a building, raise obstacles to the adoption of measures for averting this danger.

LUMINOUS ELECTRICAL TUBES.

ONE of the most convenient methods of exhibiting the illuminating qualities of electricity is by means of the Geissler tubes, which now form part of the standard apparatus of colleges and other institutions of learning. The Geissler tube—so called after the inventor, Dr. Heinrich Geissler, of Bonn, Germany—consists of a glass pipe sealed at each end, and also provided at each end with a platinum wire which projects into the tube. The atmospheric air is exhausted from the tube, a small quantity of gas or vapor is introduced, and the tube is then sealed. When the two wires are placed in connection with a Ruhmkorff coil, a stream of electrical light passes through the tube, taking various forms and colors, which vary with the kind and density of the inclosed gas. Hydrogen yields a white light; carbonic acid, green; nitrogen, yellow, etc. The most magnificent effects can thus be produced. A practical application of this discovery is a surgical lamp which consists of a small glass tube and bulb. The electric light is produced in the bulb, which may be introduced into cavities for medical examination.

Attention has lately been called to another kind of luminous tubes also produced by Dr. Geissler, in which luminosity is produced without the use of the coil and electric battery.

Such tubes, which contain small quantities of certain gases, as nitrogen, carbonic acid, hydrogen, or ammonia, become luminous after being exposed to friction with any of the well-known producers of electricity, as silk, wool, cotton, or even paper; the best, however, are cat-skin and prepared India-rubber, which is now largely employed in the manufacture of combs, etc., and which is also used in the Holtz electric machine. This mass is so very sensitive

that it is sufficient to make the tube luminous after it has passed a couple of times through cat-skin, when it is not even touched, but held two or three inches distant. When a rarefied spiral glass tube was inserted in a larger plain tube, spontaneous discharges of light would continue within the former, even after the luminous state of the whole length had ceased for some minutes, and the color of the light is dependent on the quality of the traces of gas left within the spiral tube. Thus with traces of nitrogen it is darkened, very much like the tint of the aurora borealis; with hydrogen it is a light rose, with carbonic acid a bright white, and the spontaneous discharges would be of much greater intensity at a low temperature in winter than in summer. The very curious researches of Dr. Geissler may possibly lead to a clue to the wonderful phenomenon of the aurora borealis.

Another curious discovery of Dr. Geissler was that mercury, when shaken in a rarefied glass tube, would also become luminous, and emit a strong light, so that in a perfectly dark room all objects could be distinctly seen; the color of the mercurial light could be modified by the presence of small traces of gases in the tubes. A minimum of nitrogen shows an intense red, and hydrogen a yellowish light. The capacity of mercury for producing light seems to depend on its purity, so much so that it was not luminous when it contained an admixture of tin, lead, zinc, or bismuth, but gold or silver did not affect it. It would be possible to utilize this peculiar quality of mercury for lighting up chambers filled with explosive gases, such as some parts of mines or powder magazines, instead of using the Davy lamp.

ELECTRICITY OF GAS FLAMES.

PROF. TROWBRIDGE, of Harvard, finds—1. That the flame of a Bunsen burner is negative while positive electricity accumulates on the burner itself, if it be a good conductor; when made of non-conducting material, no charge is noticed at the top of the flame. 2. The stratum of air in contact with the outer cone of flame is slightly charged with positive electricity, the partly consumed gas of the under cone being neutral. 3. The presence of flames tends to change the nature of the atmospheric electricity at any given place, reducing a positive tension to a feebly negative one. As the electricity of air during cloudy and rainy weather is generally negative, or at the most feebly positive, the author considers that his observations in some degree warrant the popular idea that great fires are followed by a change in the atmosphere inducing rain.

ACTION IN GALVANIC BATTERIES.

PROF. G. W. HOUGH, Director of the Dudley Observatory at Albany, N. Y., has made a series of experiments on galvanic batteries, extending over several months, for the purpose of investigating the cause of the decline in the strength of the electric current after the battery has been in operation a long period. It is well known that, since the invention of the American method of recording transits, the galvanic battery has become one of the necessary instruments in every first-class observatory. The application of electricity also to the registration of meteorological phenomena makes it desirable to secure the best form of battery, as well as to be able to know what is the difficulty when the battery begins to fail in its work. Some of the leading conclusions reached by Professor Hough were as follows:

1st. In the sulphate of copper battery (Daniell's form) the principal cause of decline in the strength of the electric current is due to the formation of sulphate of zinc.

2d. The quantity of electricity flowing in the external circuit depends upon the specific gravity of the sulphate of zinc.

3d. When the sulphate of zinc approaches saturation, polarization takes place in the battery itself; and, although the electro-motive force remains the same, the internal resistance may be increased more than a hundred times.

4th. The sulphate of zinc (or any fluid about the zinc) is only useful as a conductor of electricity.

5th. The copper, or negative metal, is useful only as a conductor, since it may be replaced by any other metal, even zinc itself.

6th. The internal resistance of the battery has been separated into two parts, namely, that due to the porous cell and that due to the liquids employed. The specific resistance of the liquid was found to be 13; that for a small clay cell, 17, and for a leather cell, 7. Since the resistance of the leather cell is less than one half that of a clay cell, it has been used in the construction of batteries at the observatory, as the quantity of electricity is nearly doubled without any increase of surface. For the negative metal, in place of the copper hitherto employed, we have used sheet lead.

These investigations have rendered it possible to compute, with great precision, the length of time a battery will generate its normal quantity of electricity, provided the amount of electricity flowing in the external circuit is known, and the capacity of the vessel holding the sulphate of zinc is determined. The specific gravity of the

sulphate of zinc should not be less than 15°, nor more than 38° degrees of Beaumé.

A new mechanism for the more thorough investigation of galvanic batteries has been devised by Professor Hough, but not yet constructed, by which the quantity of electricity flowing in the external circuit will be recorded in the form of a curve so long as the battery is in action. This subject is one of great interest and importance, and it is proposed by Professor Hough to continue his investigation as circumstances may permit.

THE DISTRICT TELEGRAPH.

NOT many evenings ago, an intelligent, gentlemanly-looking individual presented himself at our door in New-York and asked "if we didn't want the district telegraph put into our house." At the same time he handed over for our examination a very pretty little instrument, composed of cog-wheels and somewhat resembling a clock. "We attach the instrument to the wall," he said, "in some convenient position in your house, and to it we connect a wire leading to your roof, where it unites with another wire that extends to one of our district offices on Broadway." Pointing to a small knob, he continued: "If a fire breaks out in your house, you just push that lever, and in three minutes the firemen will be here. If thieves break in, you move that other lever, and in three minutes the policeman will make his appearance. If you want a special messenger to go upon any sort of business, night or day, you just turn this little button and in three minutes the man will be at your door ready for service. The signals you thus make are all received and recorded at our Broadway office, where we keep a force of attendants in readiness at all hours, to execute the requirements of our customers. Your wife or any other intelligent person can make the signals. We make no charge for putting the instrument into your house or for keeping it in order; but you pay us $2.50 per month for its use and fifteen cents an hour for the time occupied by our messenger in doing your business. When you go away to the country in summer, you can have an attachment put on, so fixed that, if burglars attempt to break in, an alarm will be sounded at our office, when our policemen will quickly surround the house, and catch the thief in the act." We rather liked the idea of having such a telegraph in the house, gave the order, and it was promptly put in.

In the course of a week or so afterward, thinks we to ourselves, that is our wife and we, "let's try our telegraph just for fun, and see whether the telegraph folks are as

wide-awake as they pretend, or whether they are napping." This was early in the morning, just between getting-up time and breakfast—before business begins—the hour when night-hands go home and day-hands have not yet come —the time when the manager is probably not on hand. Now let's see what this new-fangled telegraph is good for. So we pressed the knob, and there followed a slight click and a buzz. We looked at our watch, went down-stairs, took seats at the breakfast-table, when we were startled by a ring at the door-bell. "Messenger from the District Telegraph Office. Got your signal. Wants to know what is wanted," was the report that came to us. Looking at the watch we found that just two and a half minutes had elapsed since we gave the signal. We felt a little bit sheepish in being obliged to tell the messenger that we had sent for him "just for fun, to see if he was really awake," etc., and as we were entirely satisfied on that point, he retired, sorry that we had no real business for him to do.

After breakfast, we went to the company's office, where we found a Morse paper recording apparatus, with which the various dwelling-houses in the district are connected. Whenever a signal is given from any of the houses in the circuit, a gong sounds in the office, which notifies the attendant, and at the same time the telegraph clock-work is set in motion; the paper moves, and upon it a signal is stamped and re-stamped or repeated. Each house instrument gives a different signal, and the various signals, with the names of the occupants and numbers of the respective dwelling-houses, are registered or tabulated on the wall, like a hotel indicator. By glancing at the register, the attendant sees at once from what house the signal has come, also its nature, whether a fire has occurred, a robbery going on, or a messenger needed. The office is in connection with the city fire-telegraph and police offices, and instant signals are sent thither if required.

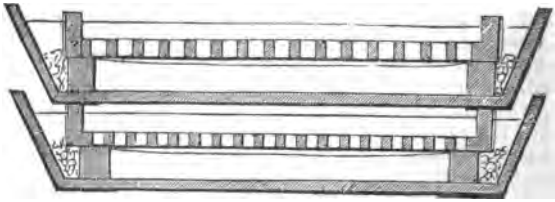
Taken altogether, this district or domestic telegraph is a most useful and valuable institution, promotive of comfort, convenience, and safety of families. That it will soon come into general use can not be doubted. The wires are so arranged that in case they are severed, either by design or accident, an alarm is instantly sounded at the district office, and the repairs are quickly effected. (83)

THE appearance of the aurora borealis is generally preceded by a marked disturbance of the magnetic needle. When such disturbance is observed during the afternoon, the aurora may be expected to be visible in the evening.

A NEW AND SIMPLE CONTINUOUS BATTERY.

PROF. BOTTOMLEY, of the Glasgow University, thus describes a new battery in use in that institution:

A shallow wooden tray, square and with slightly slanting sides, is lined with sheet lead; and this, after being electrotyped with copper, forms both the containing vessel for the liquids and the copper plate of the cell. Copper trays were used at first, but they were soon eaten through by the solution. The lead is not attacked at all The length of a side of the lead tray is 21 inches, and its depth is $3\frac{3}{4}$ inches. In each corner is set a small block of wood $1\frac{1}{2}$ inches high. The zinc plate, which is like a square gridiron, rests at its corners on these blocks. The zinc has parchment paper tied round its lower surface and sides. The cell is filled up with saturated solution of sulphate of zinc, and crystals of sulphate of copper are dropped in, when required, round the edges outside the parchment paper. For connecting these cells together in series,



the lead lining is carried over the wooden tray at the corners, and down the outside to the under surface of the bottom of it. Here it is soldered to a small square of thick sheet tin. The cells are piled up one on the top of the other, the tin plates of the second cell resting on the first, and so on. The tin connections—a suggestion of Mr. Varley—are most excellent. Two of these cells are shown in section, Fig. 5. The resistance of each of these cells is on an average 0.19 of an ohm. They are now used at all the telegraph stations where Sir William Thomson's siphon recorder is employed.

In using these batteries in a laboratory, where they are not perpetually at work, the best way of managing them may possibly be not to charge them with sulphate of copper except when they are about to be used, and only to put in as much as will do the work required. To calculate the quantity is easy, and any small excess might be worked off through a low resistance. We have been keeping them at work almost night and day. They require no at-

tention except to be occasionally supplied with sulphate of copper crystals, and to have the sulphate of zinc that creeps up over their edges wiped away with a cloth.

At present our battery is tested very frequently, generally once in four or five days. The electro-motive force and the internal resistance of each cell is determined. We have now had the greater number of the eighty cells in action for three months, and some of them for five or six months. During all that time they have been most satisfactory, the electro-motive force of them having remained perfectly constant.

ATMOSPHERIC ELECTRICITY.

THE fifty-fifth session of the Helvetic Society of Natural Sciences was held at the ancient city of Fribourg on the 19th, 20th, and 21st of August last.

Professor Volpicelli gave a paper on Atmospheric Electricity and the best method of studying it. Having made experiments, in calm weather, according to the methods both of Franklin and of Peltier, (in the former of which a fixed uninsulated rod is used, connected with an electrometer by a wire, while in the latter a movable metallic point with similar connection is sent up into the atmosphere,) he found the results always contradictory as regards the quantity, and sometimes also as regards the quality, of electricity indicated.

On all the days in which the air was not much agitated, the time and circumstances being the same, the moving rod gave a greater quantity of electricity than the fixed; and the former often showed positive electricity, while the latter showed negative.

It has been shown that the earth is a body negatively electrified. It follows that any conducting substance is electrified positively when it rises in the atmosphere, and becomes negative, on the other hand, as it descends. The indications of the metallic rod shot into the air are therefore modified by the influence of the earth, and do not give a means of determining the electricity of the surrounding atmosphere. Franklin's fixed rod, on the other hand, is free from these disturbing influences.

That a conductor gives positive electricity as it rises in the atmosphere, and negative as it descends, may be proved by experiment. Suppose, for example, the fixed rod gives negative electricity; if a flame be applied to the point of it, the apparatus will indicate positive electricity. The flame produces an upward current of air, which, by its motion, and under the influence of the earth, gives a neutralizing positive electricity, so that the point of the fixed

rod becomes positively charged. (It is necessary that the flame should have a high calorific power.)

If the flame be now brought down to the ground, one or other of three effects will occur:—if the flame is not very strong, negative electricity will be indicated; if somewhat hotter, there will be no electricity at all; if very intense, the electricity will be positive. These effects are readily explained as the resultants of two opposing actions, the production of positive electricity by the ascending current of air, and the production of negative through the influence of the earth on the descending flame. The general inference Prof. Volpicelli draws is the preferability of Franklin's method to the other. (62) (47)

REMARKABLE ELECTRICAL INSTRUMENTS.

GIGANTIC ELECTRO-MAGNET.—At a recent meeting of the Society of the Telegraph Engineers in London, first and foremost among the objects of interest was Lord Lindsay's giant electro-magnet, by far the largest in the world. It stood in one corner of the largest room, and consists of several straight, massive, horizontal bars of soft iron, running upon wheels, and so arranged as to form a rectangle; the opening between the poles is narrow, only a few inches. Lord Lindsay had to jump over the bars to get into the open square space in the centre, and observers stood outside watching his experiments. The magnet consists of more than 26 ft. of iron, each bar having a sectional area of about 36 inches; we were told, says the *Engineer*, that it weighs about six tons, and has fourteen geographical miles of conducting wire wound around it, the coils being then protected by outer casings of wood. It was charged by means of a powerful battery, but as the Grove's battery used for the purpose is not yet completed, only one fifth the power of the magnet was, according to Mr. Varley's estimate, developed at the *soirée*. Under these conditions, a plate of copper fell between the poles, at the rate, as nearly as we could judge, of $\frac{1}{8}$ inch per second, this slow fall through the air being due to the mysterious action of the magnetic rays upon the electrical currents which those rays induced in the copper plate. One experiment which particularly attracted the attention of the observers was that of inserting a lighted taper between its poles, where it burnt freely so long as the magnet was charged, but directly the current was broken and the magnetism disappeared, the taper was extinguished.

The induced current produced in the wire by the cessation of the magnetism when the battery current is re-

moved is so powerful that the shock would probably be fatal to any person who by an unfortunate accident happened to complete the circuit at the time. To guard against this, a very elaborate current reverser has been constructed by Messrs. O. and F. H. Varley, which breaks the circuit gradually by introducing resistances varying from nothing up to infinity. The magnet itself was designed by Mr. C. F. Varley. The conducting-wire weighs about 600 lb. to the geographical mile, and is nearly ¼ inch in thickness. We are told that the battery ultimately to be used with this magnet will consist of 150 of Grove's nitric acid cells, each platinum plate of which will expose a square yard of surface, both sides of the plate included. A battery of this colossal size has never before been constructed, nor indeed at all approached in dimensions.

All the parts of the magnet, as already stated, run upon wheels, and the front bars are governed by a screw motion, so as to accurately adjust the distance between the poles.

In the course of the evening Mr. Ladd froze some mercury, and the solidified metal was allowed to fall between the poles to see what diamagnetic effects would result. There were none at all so far as we could see. Most of the observers had taken the precaution of giving their watches into the charge of attendants, lest their good time-keeping qualities should be destroyed by the action of the magnet upon the steel springs.

SIPHON GALVANOMETER.—Another chief object of interest was Sir William Thomson's siphon galvanometer. The apparatus is now in practical use for the reception of messages through the Indian cables, and it is a good instrument for registering indications produced by feeble electrical currents.

VARLEY'S NEW BATTERY AND CONDENSER.—Mr. C. F. Varley exhibited a battery, very useful for testing purposes where high potency combined with extreme uniformity from day to day is of vital importance. He exhibited 1000 of these cells, as well as a number of condensers invented by him to enable submarine cables to be worked rapidly and continuously. The sheets of tin-foil in these condensers are so completely insulated, that once, when they were charged with 1000 cells and left for three months, at the end of that time enough of the charge remained to give a brilliant spark. At the *soirée* he discharged the condensers through a sewing-needle; the steel was blown into vapor and molten globules, with a loud report and a bright flash of light; some of the globules were blown to the further end of the room. Fine platinum wire was in like manner blown into vapor but not into globules.

GASSIOTT CASCADE.—Mr. Apps, the optician, exhibited a very beautiful Gassiot cascade made by him for Lord Lindsay; the electrical stream passed over the edges of a vase made of uranium glass placed under the receiver of an air-pump. He also exhibited a vacuum tube twisted into very large letters, constructed of uranium glass and exhausted to a high degree, so that only ⅛-inch spark was required to illuminate it; this was proved by allowing the spark to pass in air between the terminals of the coil. Mr. Apps also had on view several of his patent induction coils; one of them gave a spark of 6 inches in length, though of the size only, he states, of an ordinary coil giving a spark of 1½ inches.

ELECTRICAL PROBE.—One of the most useful instruments he had on view was DeWilde's electrical probe and forceps, as used in H. M.'s military hospitals and by the Prussians during the late war. The principle of the probe is that it carries within it two wires connected with the opposite poles of a weak battery; a current can not pass till the ends of the wires at the extremity of the probe touch the bullet; the circuit is then completed, and by an electro-magnetic effect the existence and position of the bullet are made known to the operator. The apparatus is intended to make bullet extraction as easy an operation as possible, attended by the minimum of pain to the sufferers.

PHOSPHORESCENT TUBES.—Among the other things which Mr. Apps exhibited were tubes containing sulphate of strontium and sulphate of barium, which remained phosphorescent many minutes after the cessation of the spark; and an improved Wheatstone's bridge arrangement, giving a scale of differences from 1000 to 1; there was also included a small ivory disc arrangement for reading off approximately very small resistances, to one millionth of an ohm.

VACUUM TUBES AND OTHER INSTRUMENTS.—They also exhibited a pencil-writing Morse instrument, for which they claimed more cleanliness and a higher rate of speed than with an ink writer; and among their instruments was one of the vacuum lightning protectors for submarine cables, used to prevent lightning which may strike the land wire getting into any cable connected therewith.

INDUCTION COIL.—Lord Lindsay exhibited among other things a large induction coil, which gave sparks twenty inches long in air; this coil was made for him by Messrs. O. and F. H. Varley. The last mentioned manufacturers exhibited a vacuum tube 9 feet long, which was brilliantly illuminated.

HEAT OF THE SUN AND LIME-LIGHT.

THE discontinuity of the solar heat-spectrum was first determined by Sir John Herschel, who with a flint-glass prism threw a spectrum on paper blackened with soot and moistened with alcohol, and estimated the thermal effect of the spectrum by the time of drying. He observed that the moistened surface dried in a series of four distinct spots. Fizeau and Foucault also noticed the existence of bands in the ultra-red rays; later observers, however, who have investigated the distribution of heat in the solar spectrum, delineate the heat-curve as continuous. M. Lamansky, during experiments on this subject, noticed that, beginning from the line D and advancing toward the ultra-red end of the spectrum, the deflections of the galvanometer, corresponding with the heat-effects, become, though not proportionately, stronger until they attain a certain maximum, and then diminish; this takes place four times, and shows that the ultra-red rays are interrupted in three places by breaks or bands. These bands have a corresponding position in spectra produced either by a glass, bisulphide of carbon, or rock-salt prism, and differ only in becoming broader when the prism used has a greater dispersive power. The breaks or bands are not equally wide; the first is much more sharply separated from the second than the second from the third. Parallel experiments with rock-salt apparatus—made the one in the morning and the other about noon—show that the breaks become somewhat narrower with increasing altitude of the sun. They were also rather deeper on the days when the relative moisture of the air was greater. M. Lamansky does not consider the observations sufficient to warrant our ascribing these bands to atmospheric absorption. In all the experiments it was observed that the heat-effect of the solar spectrum, after attaining its last maximum, sinks suddenly. A similar examination of the lime-light spectrum showed that there was no break of continuity as in the solar spectrum, and that the position of maximum heat-effect is much further from the end of the visible red in the former than in the latter. In other words, with the feebler sources of heat the intensity of heat-effect attains its maximum for rays of greater wave-length than is the case with more powerful sources of heat.

THE LATEST BRITISH "BLUE BOOK" is the "Annual Report of the Postmaster-General," which shows, among other items, that during the last year 12,700,000 telegrams were transmitted from stations in the United Kingdom.

THE ELECTRIC LIGHT.

A SERIES of experiments has been made at Sheerness, England, with a view of ascertaining the applicability of Siemens's dynamo-electric light to torpedo service in time of war. The scientific combination is produced, as its name signifies, by the application of excessively rapid motion generated from the fly-wheel of a steam engine to a very powerful set of ordinary galvanic coils in connection with a soft iron magnet. The leather strap from a four horse-power engine, encircling a small gun-metal pinion, causes it to revolve with the extreme velocity of 1600 revolutions per minute, inducing motion in an electric bobbin at the side of an apparatus consisting of several sets of strong insulated coils. A stream of electricity consequently passes through them. This stream is conducted to a second series of coils, larger and more powerful than the first, which are also in combination with a pinion revolving 800 times per minute, thus intensifying the stream as it passes through them to a very considerable degree. Both negative and positive currents are now alternately given off from another bobbin at the side of the second series of magnetic coils, to the train of insulated wires, which conveys them to the position from which the dynamo-electric light is to be exhibited. Here there is a delicately contrived apparatus for containing the carbon points between which the light is to be generated, adjusted at the top of a tripod somewhat similar in construction to that of a surveying instrument. At the back of the two carbon points, and slotted vertically to admit of their holders passing through it, is a concave reflector of white polished metal, which collects the rays of light into a focus and transmits them in any required direction by means of an adjusting hand-wheel below. A minute aperture in the centre of the reflector, precisely behind the junction of the two carbon points, throws a representation of the flame upon a piece of opal glass in a frame fixed at the back of the reflector; and through the agency of another small hand-wheel, which causes the carbon points to approach or recede from each other, the flame can be reduced or intensified at pleasure, by simply turning the wheel, care being taken at the same time to keep a watchful eye upon the picture produced, as the withdrawing of the points to too great a distance from each other will extinguish the light. It should have been remarked before that ample means are taken, by lubricating the electrical apparatus, to counteract the evil effects which might otherwise arise from the excessive friction consequent on the rapidity of motion in the several parts.

The object of instituting the series of experiments which were made was to ascertain if it was possible to throw such a stream of light upon an enemy's working parties (engaged in interrupting communications) with a line of torpedoes at night, as would render them sufficiently conspicuous to be fired at and consequently driven off. The place selected was the new fort at Garrison Point, Sheerness.

The effect was magnificent. Clouds of mist, rendered visible by the intensity of the rays shooting through them, rolled across the broad field of bright light from time to time, not, however, interrupting the view in their progress. By shifting the direction of the rays laterally, each object in turn came within the compass of the portion of the horizon rendered clear. In fact, it was sufficiently apparent that no objects of any appreciable size, such for instance as an enemy's boats, could come within a mile or more of one of Siemens's dynamo-electric instruments in operation without being rendeed conspicuous to any battery in the vicinity, and conseruently involving to themselves the most imminent dangqer. (86)

ELECTRICITY OF PLANTS.

IN the *Sitzungsberichte* of the Bavarian Academy, Dr. Ranke has recently described some researches on this subject. He observes that the similarity which has been established between animal and plant electricity warrants us in applying to the latter, with certain modifications, Du Bois-Reymond's molecular hypothesis of animal electricity. We may suppose the interior of electro-motive parts of plants filled with small peripolar molecules imbedded in a conducting substance, the axes of these (joining the poles of each molecule) being parallel to the axis of that part of the plant containing them. The theory of animal electro-motors supposes each of the molecules to have two negative polar zones, and one positive equatorial. The law of plant-electricity requires, on the other hand, for each of the molecules, two positive polar zones and one negative equatorial.

ELECTRIZATION BY FRICTION.

TH. SIDOT states that when pure sulphide of carbon is placed along with granulated silver or any other granulated metal in a stout glass bottle, and this vessel vigorously shaken, electric sparks are seen inside the bottle; when, while this phenomenon is observed, water is poured on the bottle, the appearance of the sparks ceases immediately, but the phenomenon is observed again when the shaking is continued.

BRITISH ARMY TELEGRAPH.

FOR this service there is at present one troop of the Royal Engineer train, which is divided into three sections, each carrying twelve miles of wire, in half-mile lengths. These pieces can be conveniently joined by an ebonite jointer, which makes a practically water-tight joint in less than half a minute, and which, in the case of searching for faults, can be undone in even a less time. The cable consists of a strand of seven No. 22 B. W. G. copper wires, insulated by Hooper's compound, and made three inches thick; it weighs 300 pounds per mile. For service it is carried on wooden drums, which again are placed on the "wire wagons," and are to be drawn by six horses. The wagons consist of an under-carriage and wheels of an ordinary service wagon, the whole made as light as possible of "Clarkson's material." Upon this carriage are ranged six drums in two rows, so placed on framework that the wire may be paid out as required from the rear drum as the wagon advances. Thus on each wire-wagon is carried three miles of wire and two dozen iron poles intended to lift the wire overhead when passing cross roads; for, although the insulation is so strong and good that it has stood and will successfully stand a great deal of ill-treatment, such as carts and carriages passing over it when laid unprotected on a hard macadamized road, yet it is not to be expected that any thing less durable than a rod of iron could stand the traffic of an army. The poles are formed of wrought-iron tubing in two lengths, the butt ten feet long and one and a quarter inches in diameter, the top nine feet long and one inch in diameter, fitting inside the butt and fastened, when in use, by a bayonet catch. These poles can be stayed, if necessary, by three guys provided for the purpose. The wire is held in a wooden plug which fits into the top of the pole.

There is also carried, by each wire-wagon, a hand barrow, which is fitted with legs, and, as occasion demands, with wheels, so that it is capable of taking a drum of cable when the wire-wagon may either not be able or not required to go. There are, moveover, two wrought-iron earth plates eighteen inches long, four and a half inches wide, and some one half inch thick, which are strong enough to be driven home in any possible soil, and a six-gallon cask of water to ensure some moist earth. This, with a jointed ladder of two nine-feet lengths, and some spikes to lift the wire on to a wall if wanted, comprises the main part of the furniture. There is a very neat arrangement on the hind wheel, by means of which the wire, when laid out, can be rolled up by the action of that wheel.

Finally, there is a little hooked stick for lifting the wire as delivered on to the hedges or fences which ordinarily bound the road. The office-wagon, not unlike a travelling photographer's van, contains a pair of Morse recording instruments, fitted with Siemens's polarized relay, and with Digny's felt ink-roller, which has been deliberately preferred to the possibly more scientific arrangement of Messrs. Siemens, as being more portable. The pattern of battery at present in use is a form of Daniell's, arranged for portability by Sergeant Mathison, R.E., of the Electrical School at Chatham. This school is intended to facilitate the training of men from the ranks to the duties of telegraphers.

ELECTRICAL METALS.

IT has been observed by Sidot that certain metals become electrical when rubbed in a glass with carbon bisulphide. Iron, silver, and aluminum yield sparks under these conditions, if rubbed sufficiently hard. Fifteen to 20 grams of granulated silver, and 30 to 40 grams of pure carbon bisulphide were brought into a perfectly dry glass tube, and the latter was sealed up. On warming gently and shaking in the dark, sparks appeared in the fluid, and after vigorously shaking, the tube appeared quite luminous. When cold water was poured on the outside of the tube, the luminosity disappeared, but reappeared after renewed shaking.

ELECTRICITY AS A MOTOR.

IT has been suggested by Samuel Gardener that this power would be employed by many persons for lighting gas, running sewing-machines, or other purposes, if it could be had without the trouble of attending to the battery, and he therefore proposes to erect a powerful battery in some suitable location, from which should run main wires, having branches leading to the different houses on the line. To equalize the amount of power to the requirements of each family, he proposes to place "resistants" between the main wire and that entering the house, which should limit the power to the desired amount.

ELECTRIC INSULATORS.—C. H. Pond proposes to manufacture insulators of a compound formed of one part of coal-tar, and two parts of charcoal, saw-dust, or tan-bark. These last ingredients must be thoroughly dried and incorporated with the tar. The articles are moulded of the desired shape and baked in an oven, and an insulator may thus be produced which is said to be hard, yet slightly flexible, and very cheap.

MORIN'S NEW BATTERY.

IT consists of a cylinder of copper, the interior of which is concentric with the cylinder of zinc; the annular space comprised between these two metallic surfaces is divided into two equal parts by a cylinder of filter-paper. Ordinary sandstone is put between the interior surface of the copper and the paper diaphragm, and sublimated sulphur on the side of the zinc; the whole is plunged into a solution of sulphate of copper, which penetrates through the mass, by means of the numerous minute orifices, freely to the copper. Some hundred elements prepared in this manner, and frequently in use, have been set up for more than twenty months, and the alteration which they have undergone shows that this is but half the time for which they may be worked; they have been perfectly closed during this time, and have neither been subjected to repair nor inspection.

SPECTROSCOPE PLATES.

BY E. LOMMEL.—In order to avoid the inconvenience of using solutions in glass vessels in demonstrating the phenomena of absorption of soluble coloring matters, I use gelatine *laminæ* which are colored with the matters in question. To protect them from wearing out, from air and dust, they are enclosed between two colorless glass plates; and even with delicate coloring matters they keep perfectly. A compendious collection of the most varied coloring matters may thus be made, which are always handy for demonstration, whether for the objective projection of absorption-spectra, or for subjective observation by the spectroscope. We can, for instance, at any time exhibit the changes which the spectrum of the coloring matter of the blood undergoes by various agents without needing to perform the lengthy operations with fresh blood.

The changes of the absorption-spectra, for continually thicker layers of the coloring medium, may be quickly and conveniently effected by superposing on each other a continually larger number of gelatine plates of the same thickness and the same intensity of color. The phenomena of a wedge-shaped layer may be imitated by superposing a large number of feebly colored laminæ.

METAL wires cool on being stretched, and become heated on contraction—but threads of vulcanized caoutchouc have quite the opposite comportment, becoming heated when stretched, and cooled when they contract. This remarkable fact has been investigated by physicists, and always with the same result.

PHOSPHORESCENCE BY FRICTIONAL ELECTRICITY.

BY M. ALVERGNIAT.—We make a vacuum, by means of the mercurial air-pump, in straight tubes of glass 45 centims. long; we then introduce a small quantity of chloride or bromide of silicium, and continue the exhaustion till the pressure is reduced to 12 or 15 millims., after which we close the tube at the lamp.

If the tube thus prepared be then rubbed between the fingers or with a piece of silk, a bright glimmer within the tube is seen to follow the movement of the rubber; it is rose-colored with the chloride, and greenish yellow with the bromide of silicium. It recalls that which has long been observed in the barometer, but it is brighter.

We will remark that, if we try to cause the spark of the induction-coil to pass in these tubes, it developes no light there, unless the vacuum be more perfect; but then the phosphorescence excited by the friction disappears. (4)

HIGHTON'S GALVANOSCOPE.

THE galvanoscope which Mr. Highton exhibited at the Society of Arts, and by which he showed that simply looking at a thermo-pile was sufficient to signal across the Atlantic, was constructed in the following manner: A strip of gold-leaf, the thinnest which could be procured, was hung vertically between two wires, one at the top and the other at the bottom, and metallically connected with both. There were means by a telescopic movement of adjusting the tension of the gold-leaf. The whole was inserted in a small glass chamber with flat walls and placed in a powerful magnetic field. The slightest current sent through the gold-leaf deflects it in a direction regulated by its position with regard to the poles of the magnet. A strong beam of light was then sent across the gold-leaf in a direction at right angles to its plane of motion, and by a condensing lens a magnified image of the leaf was thrown upon a screen. The motions of a gold-leaf fixed in this manner reveal in a most wonderful manner the slightest variation of an almost infinitesimal current. (2)

TO OVERCOME THE INDUCED MAGNETISM in compound electro-magnets, Isaac P. Tice proposes to make such magnets by a large and small helix around each limb—the coils being wound in opposite directions. By changing the current from the large helix to the small one, the induced magnetism caused by the passage of the current through the former is instantly neutralized, and the power lost in overcoming this in the ordinary magnetic machines is saved.

MEASUREMENT OF SPECTRUM.

M. MOUSSON describes a method for measuring the dispersion in the different parts of the spectrum furnished by a prism or any spectroscope whatever. The dispersion varies, it is known, in the different portions of the spectrum obtained with a prism, it is believed much less rapidly in the red, much more rapidly in the violet. The law according to which it varies changes according to the different prisms and different substances used. M. Mousson proposes a new simple process by means of which the law can be directly determined for each spectroscope. It consists in observing with the spectroscope the spectrum given by a network (*réseau*) of diffraction, of which the lines ought to be perpendicular if the edges of the prism are horizontal. There is thus obtained a curved spectrum, which is the graphic representation of the law sought.

A NEW SENSITIVE SINGING FLAME.

BY W. E. GEYER.—Philip Barry has recently described a very sensitive flame produced by placing a piece of ordinary wire gauze on the ring of a retort stand, about four inches above a Sugg's steatite pin-hole burner, and lighting the gas above the gauze. "The flame is a slender cone about four inches high, the upper portion giving a bright yellow light, the base being a non-luminous blue flame. At the least noise this flame roars, sinking down to the surface of the gauze, becoming at the same time almost invisible. It is very active in its responses, and being rather a noisy flame, its sympathy is apparent to the ear as well as to the eye."

A simple addition to this apparatus has given me a flame, which, by slight regulation, may be made either: (1) a sensitive flame merely—that is, a flame which is depressed and rendered non-luminous by external noises, but which does not sing; (2) a continuously singing flame, not disturbed by outward noises; (3) a sensitive flame, which only sounds while disturbed; or (4) a flame that sings continuously except when agitated by external sounds. The last two results, so far as known to me, are novel.

To produce them, it is only necessary to cover Barry's flame with a moderately large tube, resting it loosely on the gauze. A luminous flame six to eight inches long is thus obtained, which is very sensitive, especially to high and sharp sounds. If now the gauze and tube be raised, the flame gradually shortens and appears less luminous, until at last it becomes violently agitated, and sings with a loud uniform tone, which may be maintained for any

length of time. Under these conditions, external sounds have no effect upon it. The sensitive musical flame is produced by lowering the gauze until the singing just ceases. It is in this position that the flame is most remarkable. At the slightest sharp sound, it instantly sings, continuing to do so as long as the disturbing cause exists, but stopping at once with it. So quick are the responses that, by rapping the time of a tune, or whistling or playing it, provided the tones are high enough, the flame faithfully sounds at every note. By slightly raising or lowering the jet, the flame can be made less or more sensitive, so that a hiss in any part of the room, the rattling of keys, even in the pocket, turning on the water at the hydrant, folding up a piece of paper, or even moving the hand over the table, will excite the sound. On pronouncing the word "sensitive," it sings twice; and in general, it will interrupt the speaker at almost every "s" or other hissing sound.

The several parts of the apparatus need not be particularly refined. By the kindness of President Morton I have used several sensitive jets of the ordinary kind made of brass; they all give excellent results. Glass tubes, however, drawn out until the internal diameter is between one sixteenth and one thirty-second of an inch, will do almost equally well. For producing merely the singing flame, even the inner jet of a good Bunsen burner will answer. The kind of gauze too is not important; I have generally used a piece which had been rounded for heating flasks; it contained about 28 meshes to the inch.

The experiments can be made under the ordinary pressure of street gas, three fourths of an inch of water being sufficient. (7)

CURIOUS OPTICAL EXPERIMENT.

Les Mondes describes a curious experiment of M. R. P. Lafond. Take a chameleon top, and place on the centre one of the prismatic disks which can be bought with the article, and instead of producing the singular optical illusions usually obtained from these disks by means of the fingers, (in the same way as the "checked action" of Wheatstone is produced,) illumine the table with a large Geissler tube. The result is described as charming; the most varied combinations of colors and designs succeed each other without any necessity for touching the disks and consequently destroying the movement of the top. Moreover—and this makes the plaything a veritable scientific instrument—we have here a beautiful demonstration that the light of the Geissler tubes is intermittent.

THE ULTRA-VIOLET RAYS.

THOUGH under ordinary conditions only the portion of the spectrum which lies between A and H is visible to the eye, it has been found by Sekulic that the rays beyond the violet are distincly seen if *direct* sunlight be allowed to fall upon the prism. Fraunhofer's lines as far as the N group makes their appearance, and the M group comes out so clearly that its third broad line can be easily covered with the wire of the telescope. The N group is somewhat indistinct, only the bright bands being identified. The color of this light is pale-blue or silver-gray. When examined with blue glass, this portion of the spectrum resembles a pale-blue vapor, at the background of which lie the dark lines; by using a violet glass, it appears as a silver-gray band with the lines on a completely dark field. The lines of this very refrangible portion of the spectrum agree most completely with those of the photographic spectrum given in Müller's *Lehrbuch der Physik.* (44)

THE LUMINIFEROUS ETHER.

THOUGH compelled to think of space as unbounded, there is no mental necessity to compel us to think of it either as filled or as empty; whether it is filled or empty must be decided by experiment and observation. That it is not entirely void, the starry heavens declare, but the question still remains: Are the stars themselves hung in vacuo? Are the vast regions which surround them, and across which their light is propagated, absolutely empty? A century ago the answer to this question would be: "No, for particles of light are incessantly shot through space." The reply of modern science is also negative, but on a somewhat different ground. In support of the conclusion that the celestial spaces are occupied by matter, it is able to offer proofs almost as cogent as those which can be adduced for the existence of an atmosphere round the earth.

The notion of this medium must not be considered as a vague or fanciful conception on the part of scientific men. Of its reality, most of them are as convinced as they are of the existence of the sun and moon. The luminiferous ether has definite mechanical properties. It is almost infinitely more attenuated than any known gas, but its properties are those of a solid rather than of a gas. It resembles jelly rather than air. A body thus constituted may have its boundaries; but, although the ether may not be co-extensive with space, we at all events know that it extends as far as the most distant visible stars. In fact it is the vehicle of their light, and without it they could not be seen. This all-pervading substance takes up their mole-

cular tremors, and conveys them with inconceivable rapidity to our organs of vision. It is the transported shiver of bodies countless millions of miles distant which translates itself in human consciousness into the splendor of the firmament at night. If the ether have a boundary, masses of ponderable matter might be conceived to exist beyond it, but they could emit no light. Beyond the ether dark suns might burn; there, under proper conditions, combustion might be carried on; fuel might consume unseen, and metals be heated to fusion in invisible fires. A body, moreover, once heated there, would continue forever heated; a sun or planet once molten, would continue forever molten. For, the loss of heat being simply the abstraction of molecular motion by the ether, where this medium is absent no cooling could occur. A sentient being, on approaching a heated body in this region, would be conscious of no augmentation of temperature. The gradations of warmth dependent on the laws of radiation would not exist, and actual contact would first reveal the heat of an extra etheral sun.—TYNDALL.

CONVERSION OF VIS VIVA INTO HEAT.

IT is well known that a fall of temperature is recorded when a current of compressed air is driven against the face of a thermo-pile. Volpicelli, on allowing air which had been cooled to the ordinary temperature to escape from a pressure of four atmospheres against a thermo-pile, noticed three effects. When the nozzle was near the pile, a rise of temperature was remarked; when it was removed to some distance, a fall of temperature was observed; and when it occupied an intermediate position, the needle remained motionless. The causes of these variations of temperature are of three kinds: one arises from the destruction of the vis viva of the air; a second is brought about by the condensation of the molecules of air in the pores of the metal of the pile; and a third is due to the expansion of the molecules during their passage. The first two causes produce a rise, the third a fall of temperature. The movement of the needle will show whether the first two causes of variation are greater, equal to, or less than the third. Volpicelli's observations accord with those already described by Tyndall in his lectures on Heat.

THE ELECTRICAL CONDUCTING POWER of a metal is diminished by heating it. A poor conductor is more easily heated by an electrical discharge than a good conductor. Thus a stroke of lightning that would fuse an iron rod would not injure a copper rod of the same dimensions. The conducting power of copper is 120, while that of iron is only 24.

SUSCEPTIBILITY OF THE EYE TO COLOR.

THE human eye, it is found, is over a considerably wide range susceptible to changes of brilliancy of white light, when the differences are equal fractional parts of the total luminous effect. Experiment has shown that on an average a change of one-hundredth of the total luminous effect, or even under favorable circumstances from $\frac{1}{150}$ to $\frac{1}{160}$, can be recognized. Dobrowolsky has experimented with the various colors of the spectrum (*Der Naturforscher*) and determined the limit of susceptibility of the eye to changes of brilliancy in each instance. He finds it to be for red, at A, $\frac{1}{14}$; at B, $\frac{1}{19.76}$, and at C, $\frac{1}{25.18}$; for orange, between C and D, $\frac{1}{33.18}$; for golden yellow, at D, $\frac{1}{43.77}$; for green, between D and E, $\frac{1}{38.7}$; for bluish green, between E and *b*, $\frac{1}{67.35}$; for cyanogen-blue, at F, $\frac{1}{134.8}$; for indigo, near G, $\frac{1}{268}$; and for violet, between G and H, $\frac{1}{268}$; and at H, $\frac{1}{67.35}$, at which point the intensity of the light fails. These numbers show that the susceptibility of the eye to these changes of brilliancy increases continuously as we pass from red to violet, being in the case of the latter color from ten to twenty times what it is with the red. These observations agree with what has been noticed by Helmholtz, that by a proportional decrease of illumination of brilliantly colored surfaces the red fades from sight more rapidly and sooner than the blue.

SPECTRUM OF THE AURORA BOREALIS.

BY H. C. VOGEL.—The author has used an eleven-inch equatorial with an appropriate star spectroscope, furnished with a direct vision-prism made up of five prisms, with a refracting angle of 90°. About 100 lines of the solar spectrum were measured in the instrument, to allow any new lines observed to be easily reduced to wave-length measurements. The author gives his observations and measurements of lines taken on five occasions from October, 1870, to April, 1871. In order to compare the lines observed with those of terrestrial bodies, he has examined the spectra of oxygen, hydrogen, nitrogen, and of atmospheric air in Geissler's tubes; he does not, however, appear to have examined these gases under different conditions of pressure and temperature, but only the spectra obtained in different parts of the same tube. The wave-lengths of the various lines have been calculated, and are given in detail. The author's observations lend a considerable support to the view that the spectrum of the aurora borealis is a modification of the air spectrum. A comparison of some of the lines observed in auroræ with the lines of iron show a tolerable coincidence, with the excep-

tion that the relative intensities of the lines in the two spectra are not the same. The author thinks that if it could be shown that the lines of iron could be made to assume the relative brightness of the lines observed in auroræ by a change of temperature or pressure, the coincidence would be almost sufficient to prove the existence of iron in the stratum of our atmosphere where auroræ take place.

SUBMARINE WARFARE.

MR. QUICK, an ingenious Englishman, has devised a torpedo which is intended to be fired below water-line into the unprotected bottom of an enemy's vessel. Mr. Quick has enjoyed the advantage of a practical trial of his invention under the auspices of the British government. The trial recently took place at Shoeburyness; but the result was not very flattering, and must have been any thing but entertaining to the spectators who were thereby endangered.

A ten-inch gun was laid on the beach at about 5 degrees elevation, at a spot which would be covered by about three feet depth of water at high tide. The bore was closed at the muzzle by a disk of glass fixed in a wood washer tightly sealed round the edge, while an electric wire led through the vent of the gun to a small igniting charge in the centre of the base of the torpedo. The torpedo itself was a cylinder something over five feet long, with a sharp-pointed head, and immediately behind it was a space intended to be filled with gun-cotton. The after part of the body contained four rockets, which were in communication with the igniting charge, and whose gas escaped on ignition through spiral vents designed to give rotation to the torpedo, and keep its axis steady while projecting it through the water. On this occasion, the gun-cotton bursting charge was dispensed with, the object being to ascertain what range and direction might be obtained.

When the tide rose and covered the gun, the experiment took place. On firing, the torpedo burst open close to the muzzle of the gun, two rockets rising into the air, one of which descended again almost immediately, while the other flew high over the heads of the spectators. The conditions governing the rocket's motion under water are even more complicated than those in air; the pressure of the gas in every case, of course, increases with the depth of water above the rocket. In fact, to obtain the full development of force without risk of bursting the case, a certain given depth is required. Success could hardly be expected to follow a preliminary trial on a

large scale. Even supposing such an engine to be desirable, Mr. Quick's torpedo has hardly reached the stage of development desirable for a public trial; the same forces which cause the *ricochet* of a shot in water, or, in fact, the bounds of a stone thrown by hand to skim in "ducks and drakes," would always give a submarine rocket, if not moved with a high velocity, a tendency to rise like a Venus out of the sea.

COLOR OF THE METALS.

THE rays thrown off from a colored object are mixed more or less with white rays, because the light illuminating the object is incompletely decomposed. The color of a brightly polished metallic surface is usually invisible, because the coloration due to decomposed light is disguised by the more powerful reflected light. As, moreover, attempts to develop the actual color of a metallic surface by reflecting white light a great many times from it fail through the loss of the colored lights by dispersion, Seely has proposed a modification of the experiment. As, when white light is decomposed, the reflected colored ray is complementary to that which is transmitted or absorbed, he recommends the examination of solutions of metals in a fluid that is without chemical action on them. For the alkaline metals he used dry liquid ammonia, in which they slowly dissolve, forming a solution that appears blue by transmitted light; and he concludes therefore that the color of these metals by reflected light is red like copper. (43)

ARTIFICIAL MIRAGE.

BY PROF. C. MAXWELL.—The apparatus used for the purpose consisted of a cubical vessel, with plate-glass sides, six inches square, and containing three liquids of different specific gravities. The lowest solution was of saturated alum-water, the highest pure water, while the intermediate one contained Scotch whisky mingled with sufficient sugar to bring its gravity between the two. Through this instrument triple images of an extended landscape could be obtained without difficulty, the middle image being inverted.

CUTTING DOWN TREES BY ELECTRICITY.

A METHOD of dividing wood, proposed by George Robinson, consists in interposing a fine platinum wire between two copper wires connected with a battery which causes the platinum to become red-hot, and may then be used to fell trees or divide wood by simply guiding the wire along the line where the wood is to be separated.

RECURRENT VISION.

PROF. YOUNG has observed some peculiar phenomena relating to vision whilst pursuing a series of experiments with a new double-plate Holtz machine. The machine gives easily intense Leyden-jar sparks, from 7 inches to 9 inches in length, and of dazzling brilliance. When, in a darkened room, the eye is screened from the direct light of the spark, the illumination produced is sufficient to render every thing in the apartment perfectly visible; and what is remarkable, every conspicuous object is seen twice at least, with an interval of a trifle less than one quarter of a second—the first time vividly, the second time faintly; often it is seen a third, and sometimes, but only with great difficulty, a fourth time. The appearance is precisely as if the object had been suddenly illuminated by a light, at first bright, but rapidly fading to extinction, and as if, while the illumination lasted, the observer were winking as fast as possible. Whatever the true explanation may turn out to be, the phenomenon at least suggests the idea of a reflection of the nervous impulse at the nerve extremities, as if the intense impression upon the retina, after being the first time propagated to the brain, was there reflected, returned to the retina, and from the retina—traveling again to the brain—renewed the sensation.

ELECTRIC TORCH.

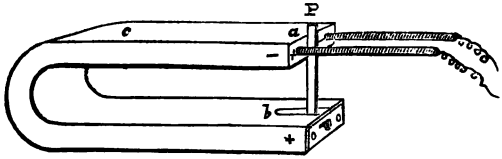
AN electric torch for lighting gas, devised by William W. Batchelder, consists of a generator to be held by a handle, from which rises a metal rod terminating in a goose-neck, having depending therefrom an insulated bell-shaped gas-receiver, with an opening at one side to allow of the deflection of the gas toward a liberating point connected with the rod. Between the generator and deflector or receiver a connection is made by a chain. By placing the receiver over the gas-burner the explosive mixture of air and gas formed therein when the gas is turned on is deflected through the hole and is ignited by a spark from the liberating point caused by operating the generator.

SYMPATHETIC VIBRATIONS.

PROF. E. J. HOUSTON states an interesting acoustical observation, namely, that of a sensitive waterfall. He was led to make a trial upon a waterfall at a point where the body of water was divided up into a great number of fine threads dripping from the mass, and after several attempts at sounding the proper note, he finally succeeded in calling one to which many of the threads responded,

NEW TELEGRAPH RELAY.

M. D'ARLINCOURT has invented a relay said to be very easily adjusted and effective in its working. At the negative extremity *a* of a powerful horse-shoe magnet *c* are fixed the two poles of an electro-magnet. A vertical bar of iron P, centred at *b* in the positive pole of the horse-shoe permanent magnet, and therefore permanently positively magnetized, vibrates between the two poles of the electro-magnet on the other extremity of the horse-shoe magnet. When a series of currents are passed through the wires of the electro-magnet, the bar P necessarily executes a corresponding series of vibratory move-



ments, being displaced from the positive pole of the electro-magnet, to which it returns on an interruption or change in the direction of the current. In this relay it is said that the difficulty of residual magnetism, arising from the coercive force of the iron of the electro-magnet, is removed, and that the degree of rapidity of the oscillations of the bar consequently depends upon the rate at which the current can be made and interrupted in the line. With the relay disposed as a translating apparatus at Paris, messages were transmitted from Marseilles to London, traversing the cable at Dieppe. The trial showed the relay capable of being worked at a high speed and with great precision. (26)

MAGNETS.

TO enable one magnet to simultaneously operate several armatures, William E. Davis proposes to make the top of the core in the form of a cross, each arm of which will operate on a separate armature.

A NEW insulator, introduced by Moses G. Farmer, is composed of earthen or stoneware baked in the usual manner and then saturated in a mixture of twenty-four parts of rosin, sixteen of bees-wax, eight of spermaceti, and one of oil.

ORIGIN OF OZONE.—A. HOUZEAU.—As regards the origin of ozone, the author holds it to be due to atmospheric electricity constantly acting in the manner of a huge-sized condenser between the soil and the clouds.

THE WEST-INDIA AND PANAMA TELEGRAPH.

THE completion of the West-India and Panama Telegraphs, which was commenced by Sir Charles Bright in 1870, brings the West-Indies, Central and South-America into telegraphic connection with the United States, and, through them, with all countries where telegraphic systems are in existence.

The cable sent out for this arduous undertaking was 3600 miles in length, weighing upward of 8500 tons, and was divided between seven large vessels, and the magnitude of the enterprise, which included the laying of sixteen separate cables under greatly varying depths and conditions, and in several cases during rough weather, is unequaled in the annals of telegraphy.

Many difficulties had to be overcome, especially in laying the shore ends, and providing land lines through dense forests, while the deleterious nature of the climate led to a loss of a number of the staff.

Owing to the irregular character of the bottom, varying from two to upward of 2000 fathoms, four types of cable had to be employed, the first or shore end, weighing sixteen tons to the mile, and the other respectively five tons, $2\frac{1}{2}$, and $1\frac{3}{4}$, the last being covered with galvanized homogeneous iron wire akin to steel. The shore end cable has two massive coverings of galvanized iron wire laid spirally in opposite directions, and all the kinds of cable are further covered with two servings of yarn and Bright and Clarke's compound as a protection against the teredo navalis and other marine insects.

The cables unite Havana at one end of Cuba with Santiago, and Santiago with Jamaica, whence they extend on the one hand to Colon, and on the other to Demerara, linking up Porto Rico, St. Thomas, St. Kitts, Antigua, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Barbadoes, Grenada, and Trinidad.

Starting from Havana, which was previously in connection with Florida, the line passes across the Island of Cuba to Batabano, where the submarine system commences. From this point, for about 100 miles, the cable is laid along a tortuous course in very shallow water, passing between rocky islets and coral reefs, and the coast being imperfectly surveyed previously, it was necessary to make a most careful study of the bottom, and to sound over the whole of the route to find a soft and safe bed for the cable. The type of cable used on this section being of the heavy class, a great deal of manual labor was needed, and it was also requisite to employ a number of small vessels of light draught.

After passing Cienfuegos the line was laid in deep water along the Cuban coast to Santiago, and the cable was landed amid much rejoicing. The next section laid was to Jamaica, landing it at Plantation Garden River, a work of great difficulty. The west length commenced was that between Jamaica and Colon, where there is a land telegraph across the Isthmus of Panama. The line is one of great importance, and as the traffic and mails from the whole of the western coasts and South-America and the central states, comprising Peru, Chili, Colombia, Venezuela, Costa Rica, &c., concentrates at Panama. Shorly after the expedition started from Colon northward, yellow fever broke out on board the Dacia; three of the cable men were buried at sea, and many others were on the sick-list. The weather became bad, preventing observations, when, about 300 miles from Colon, a fault was discovered a short distance from the ship, and in endeavoring to pick it up an accident happened, and the end of the cable was lost. Rough weather followed, and interfered with grappling observations. Upon the return of the Dacia to Kingston a number of the cable staff died from yellow fever, and many others had to be invalided home; and as it was in a bad season of the year for grappling work, it was decided to go on with eastern sections, and then return to the Colon line.

The next length completed was between the islands of St. Thomas and Porto Rico, and in succession the rest of the lengths were laid down to Demerara, where, owing to the shallowness of the approach and the liability to ships anchoring over the route, the unusual length of 35 miles of the heavy shore-end cable was submerged, partly from schooners, as the steamer's draught was too great to allow her to approach within 10 miles of landing-place.

The cable which had been lost between Colon and Jamaica was picked up by Sir Charles Bright on December 11th, 1872, from a depth of 1400 fathoms, in latitude 13.58, longitude 7.82. It was then joined up to Jamaica, and the whole of the lines are now in working order.

QUICK TELEGRAPHING.

THE President's Message reached the telegraph office in Washington at twenty-five minutes past 1 o'clock. Within forty-five minutes, the shortest time ever attained with so long a document, it was transmitted to New-York, Philadelphia, and Baltimore. Twelve wires were used, and the weather was favorable for working purposes. There were 11,339 words in the message. Within four hours after leaving Washington it was published in full in the evening papers and sold about the streets in this city.

NEW SUBMARINE TELEGRAPH CABLE.

TELEGRAPH cable works have been erected on the Pacific coast, at San Francisco, and the Electrical Construction Company have completed the first section of their first job, to wit, a cable for the British Columbian Government. It is intended to be submerged under Rosario Straits, to connect Vancouver's Island, at Victoria, with the Continent.

The cable is 35,000 feet in length, and weighs about 30,000 pounds. The conductor is composed of seven No. 20 copper wires of 97 per cent fineness. The dielectric consists of two coats of pure gutta-percha $\frac{9}{32}$ of an inch in diameter, with intermediate coatings of Chatterton's compound. The gutta-percha coil is served with two coats of machine-banding, well tarred, and covered with a protecting armor of No. 9 galvanized iron wires, laid on spirally. Electrically tested, the resistance of the conductor is eight ohms, or B A units, per knot, and the resistance of the dielectric or insulating medium, 443,000,000 ohms per knot. The company has an order on hand to manufacture another cable 30,000 feet long, for the Puget Sound Telegraph Company, to establish a connection between Seattle and Port Townsend.

THE AUSTRALIAN TELEGRAPH.

THE *Chronicle* has published congratulatory telegrams which passed between the Mayor of Adelaide, in Southern Australia, and the Mayor of San Francisco. The telegrams referred to had to pass over 16,000 miles to reach their destinations, and as this is the first telegraphic message that ever was sent so far, we give the route over which it came as an item that may prove of interest to the readers of the *Chronicle*. It came across the Australian continent, under the Indian Ocean, through the Sunda Islands to Hindostan, under the Arabian Sea, through the Red Sea, over the Isthmus of Suez, under the Mediterranean, over Western Europe to London, under the Atlantic Ocean to New-York City, and overland to San Francisco. It was received and published in San Francisco on the same day that it was dated; the science set nature's laws at defiance. If the forwarding machinery were perfect and expeditious in its workings, such a telegram ought to reach the Pacific coast within a few moments after its departure from Australia, which would be, by our solar time, nearly fifteen hours before it was sent! As, if it was dispatched at 6 o'clock in the morning from Melbourne, it would reach San Francisco at 3 o'clock in the afternoon of our previous day.—*San Francisco Chronicle.*

THE TELEGRAPH BETWEEN GREAT BRITAIN AND AUSTRALIA.

THE following are the details of the telegraphic route from Falmouth, Eng., to Port Augusta, Australia:

	Miles.
Falmouth to Gibraltar, via Lisbon cable	1,250
Gibraltar to Malta (cable)	981
Malta to Alexandria (cable)	819
Alexandria to Suez (overland line)	224
Suez to Aden (cable)	1,308
Aden to Bombay	1,664
Bombay to Madras (overland)	600
Madras to Penang (cable)	1,213
Penang to Singapore (cable)	301
Singapore to Batavia (cable)	560
Batavia to Bangoewangi (wire)	480
Bangoewangi to port Darwin (cable)	970
Port Darwin to Port Augusta (wire)	1,800
Port Augusta to Adelaide	21
Total	12,382
Lisbon to Falmouth	268
Total	12,650

SIGNALING BETWEEN TRAINS.

MR. R. K. BOYLE, of Brooklyn, N. Y., is the inventor of a system of signaling, by electricity, between trains or locomotives on the same track, to prevent collisions, alike by trains meeting when traveling in opposite directions as by one train overtaking another, and serviceable especially in going round curves or through tunnels, and at night or in foggy weather. It consists of an arrangement whereby the circuit is formed by or through the trains on the same track, the rails of said track, and a third or ordinary rail of an adjacent track or additional rail of the first-mentioned track, without insulating any of the rails; also in a circuit-closer, carried by each train, and adjustable by the engineer, relatively to one of the rails, to open and close the circuit. This part of the invention likewise embraces a peculiar manner of hanging and operating the circuit-closer, whereby, when adjusted to break the circuit, it is both raised and drawn inward toward the side of the train, so as to be out of the way. A wire brush, forming part of the circuit-closer, is used to establish contact with the rail.

NEW TELEGRAPH INSTRUMENT.

REV. HENRY HIGHTON, of Putney, England, has produced a novel telegraph instrument, which consists in placing a strip of very thin gold-leaf in the telegraph circuit at the receiving station, so arranged as to hang between the poles of a constant magnet. Very feeble currents of electricity will deflect the gold-leaf, and telegraphic signals are thus produced.

INSULATOR TESTS.

IN a test of glass insulators of the Compromise pattern, where the tie-wire is attached to the centre of the insulator, after one year's exposure and during a heavy rain, the resistance per insulator was found to be 4,030,000 ohms; and during a heavy fog 11,000,000 ohms.

In a test of glass insulators of the new Western Union pattern, after an exposure of one month, tested during a thirty-six hours' rain, the resistance per insulator was found to be 49 megohms.

In a test of the Pond insulator, under the same circumstances, and with a similar exposure, the resistance per insulator was found to be 850 megohms.

A test of the same glass insulators, after a forty-eight hours' rain, showed a resistance of 30 megohms per insulator, and Pond's insulator, under the same circumstances, gave 525 megohms per insulator.

ELECTRIC TIME-SIGNALS.

BY PROF. S. P. LANGLEY.—The necessity of a uniform standard of time for the railways of the United States, is one which is growing into importance with the increasing extent of our railway system, and we are, ere long, in this country, to be called on to settle for ourselves a practical problem which has already been solved in England, and which is beginning to make its demand for solution upon the managers of our railroads.

The subject was first specially considered at the Allegheny Observatory some three years ago, and a plan was arranged for the managers of the Pennsylvania Central Railroad in 1869. Previously to this, however, at the request of some jewelers of Pittsburg, the time had been transmitted to their stores, at a distance of some miles from the observatory. The system now described has been in use for nearly three years, in furnishing the Pennsylvania Central Railroad with its official standard of time, and by it the time is now sent daily to Philadelphia on the east, as far as Lake Erie on the north, and to Chicago on the West—regulating the clocks on a number of the minor roads over whose wires it goes, as well as on those of the principal southern lines connecting the Atlantic with the Mississippi. Thus passing, as it does, over several thousand miles daily, it is believed to be at present one of the most extended systems of time distribution in the world.

The observatory is on the summit of the ascent, on the northern side of the valley of the Ohio, about two miles in a direct line from the offices of the Western Union Telegraph Company in Pittsburg, and rather more from those

of the Pennsylvania Central, and Pittsburg, Fort Wayne, and Chicago roads. It is connected with these points by three independent lines of telegraph. One of these runs to the Western Union offices, and thence to the stores of a considerable number of jewelers in Pittsburg. This is called the "Jewelers' line." The second, connecting the observatory through the offices mentioned with Eastern Pennsylvania and New-Jersey railways, and also with Chicago, is known as the "Railroad line." The third, consisting of a double wire or "loop," communicating with the city, is employed occasionally for the observatory's own messages, and when (as, for instance, in longitude determinations) it is wished to send sidereal time without interrupting the regular transmission of signals from the mean-time clock. In the transit-room, in the western wing of the observatory, are kept the sidereal clock, by Frodsham, of London, and the principal mean-time clock, by Howard, of Boston.

On the escape-wheel arbor of this, the standard mean-time clock, and turning with it once a minute, is a wheel cut with sixty sharp radial teeth, of which those corresponding to the 50th, 51st, 52d, 53d, 54th, and 59th seconds of the minute have been removed by a file. Near the clock is a "repeater," the circuit through whose coils passes through a local battery, through a second clock in the computing-room, and then through the standard clock. Each wire terminates in a delicate spring, close by the wheel just mentioned. While the extremities of these springs, which are shod with gold and platinum, rest in contact, the circuit is unbroken; it is opened by the minutest lifting of one from the other, and this is effected automatically by means of a ruby attached to one of them, and placed within reach of the wheel above mentioned. As each of these teeth passes, the ruby, and with it the spring, is lifted through a minute distance. (Not in practice more than one one hundredth of an inch, and usually much less.) Once a second, therefore, the circuit is opened during a period of probably less than a twentieth of a second, and as the wheel advances a tooth with each vibration of the pendulum, the armature of the repeater is raised each second of the minute until the 49th is completed.

Since the teeth corresponding to the next five seconds have been filed away during those seconds, the jewel is not touched nor the circuit opened. The consequent silence of the "repeater's" beats draws attention to the fact that the end of the minute is approaching, its comple-

tion being indicated by the short pause caused by the absence of a tooth at the 59th second.

This action is repeated in every minute of the twenty-four hours without variation. The particular second is thus identified, but one minute is (so far as the action of the standard clock is concerned) not distinguished from another. To do this is the work of the subsidiary clock in the computing-room, through which the local wires are led, as has been mentioned. This subsidiary clock (made by Howard, of Boston) may be called for distinction the "journeyman," and its principal office is not to give the time, but to interrupt the circuit, which it does on or near the completion of the 58th minute, closing it again about half a minute before the completion of the hour. When the circuit is opened by the journeyman the repeater is silent for a minute and a half; when it is closed, the standard is again heard ticking on the repeater, and the ensuing short pause evidently precedes the first second of the first minute of the hour. The time is thus wholly derived from the standard clock, and is independent of any other, the journeyman having no power to control or in any way react upon the primary, and being able only to interrupt the messages it sends, not to falsify them.

The mechanism for effecting the transmission of the time is essentially that already described, but more is needed to insure against possible interruption. This may occur from several causes, prominently from oxidation of the platinum or gold contact surfaces, when the current must be interrupted while they are cleaned, if there be no other clock. To meet this contingency a chronometer of peculiar construction was made for the observatory by Frodsham. It resembles the ordinary marine chronometer in external appearance, but contains in miniature the apparatus for breaking circuit already described, the wheels being cut so as to give the same signal of the approaching end of the minute as the standard clock. The peculiarity consists less in this, however, than in a device by means of which it can be caused to gain or lose any fractional part of a second, or any number of seconds, without being stopped, and without any disturbance of its normal rate, except while the change is being effected. This chronometer is to replace the prime clock in the circuit, during any temporary stoppage of the latter for repair or adjustment.

The mechanism which has just been described acts in connection with the local circuits of the observatory—one battery being employed for the sidereal clock and chronograph, and another for the mean-time standard. Any

interruption of the main external circuits is shown at once, by the action of a galvanometer in each, which makes an audible and visible signal when the circuit is opened. The accessory apparatus, such as batteries, relays, switch-boards and so forth, which are used in every telegraph office, it will be superfluous to describe here in detail; but before following the operation of the electric current, outside the observatory, it will be well to speak of the method which has been adopted as likely to insure most accuracy in the time-keepers which control it.

The transit instrument in the western wing is of four inches aperture, and with it and the chronograph observations for time are made on every fair night of the year except on Sunday, when, if complete determinations have been made on the preceding night, none are taken. The instrument is of sufficient power to follow the principal Nautical Almanac stars in the day, and these are used (or more rarely the sun) when the weather permits, if the usual night observations have been missed. From three to six stars are customarily taken, the azimuthal error of the instrument being found from the observations of each night, after the other corrections are applied, and the results determined from the chronograph and the sidereal clock. The mean error in the resulting determination of the sidereal clock correction, is from three to four hundredths of a second, but it can not be assumed that that of the mean-time standard is known within these limits except at the time that the observations are freshly made.

Of the very numerous plans for controlling distant clocks, that of Jones (now well known) appears to be the best; but even this is not quite reliable where the circuit is a long one. The clocks described have subsidiary apparatus, enabling them to send controlling currents on the Jones plan; but thus far its use has been confined to the observatory, has therefore been hitherto done by the sending of signals, through which distant clocks may be *regulated*, but without employing means for their *control*, and this is done over a very extended field.

The "jeweler's wire" passes through the Western Union telegraph offices and the stores of the principal jewelers of Pittsburg. Beside each "regulator" is a telegraphic sounder, on which the observatory time is heard constantly ticking, and by which almost, if not quite, all of the clocks and watches of the city are thus at second-hand regulated. There is, in this uniform and recognized standard, everywhere accessible, a convenience to watchmakers, of course, but still more to the public, as the discrepancies between clocks, public or private, which cause so

many lost minutes in the day to each person in a city, that their aggregate represents a large draft upon the time of the business public, disappear.

Distant cities, such as Chicago or Philadelphia, can be reached only by the wires of the telegraph or railroad companies, which are too valuable to be exclusively employed for this purpose. The method used on the Pennsylvania Central, and Pittsburg, Fort Wayne, and Chicago roads will sufficiently illustrate the system as applied to railways.

A special wire connects the observatory with the office in which the wires owned by these roads unite. In this office is a small bell, which is struck lightly every second, in the manner described, and except for the pauses to designate the minute and hour, continues to sound unintermittingly, affording to the conductors and other employees especially concerned in the time a means of ready comparison, even without entering the building.

At 9 and at 4, Altoona time (ten minutes fast of Pittsburg) the Pittsburg operator in charge connects the main eastern wire to Philadelphia, 354 miles distant, with the observatory, and for the ensuing five minutes the beats of the Howard mean-time standard are automatically repeated on similar bells, or on the customary "sounders" in Philadelphia, and in every telegraph office through which the road wire passes—all station clocks and conductors' watches being compared with it as the official standard. After five minutes the clock is "switched" by the Pittsburg operator out of the main line wire, which is returned to its ordinary use.

A similar set of signals, lasting for five minutes, is sent at 9 and 4 of Columbus time (thirteen minutes slow of Pittsburg) to all stations as far west as Chicago, inclusive, in the main western line, (of 468 miles in length.) At Philadelphia the time is repeated to New-York, at Harrisburg to Erie, (333 miles), etc. As it is thus sent not only over the main lines from New-York to Chicago, (nearly a thousand miles,) but over a number of subsidiary or branch roads too great for enumeration here, and which form in the aggregate a much larger number of miles than the main trunk, it will be observed that a considerable fraction of the railway system of the whole country is prepared for using a single unit of time; as, though the names of "Philadelphia time," "Altoona," or "Columbus time" are not yet abolished over that part of our railway system referred to, every railroad clock and watch, and the movement of every train is regulated from a single standard—that of the clock in the observatory.

The advantages of this uniform and wide distribution of exact time in facilitating the transportation of the country, and in enhancing the safety of life and of merchandise in transit between the Western and the Atlantic cities, seem to be sufficiently evident. The fact that the system described in this article has obtained the extension it has, within three years from its commencement, will, it may be hoped, justify the belief that its use has proved not only valuable to railways, but an added security to the safety of the public. (7)

GAIFFE'S GALVANIC BATTERY.

M. GAIFFE has recently introduced to notice a new electric pile, devised by him with a special view to its universal cheap production. It resembles in form Callaud's cell, which has been employed for some years on telegraph lines, but the elements are different. The poles are rods of lead and zinc, immersed in a ten per cent aqueous solution of ammoniacal chlorhydrate, contained in a suitable vessel. The zinc rod is only half the whole depth, whereas the lead rod reaches to the bottom, where there is a layer of saline oxide of lead, (minium.) The electro-motive power of this pile is about one third of that given by a Bunsen couple; its internal resistance is small and little variable, as the chloride of zinc formed does not sensibly change the conductibility of the exciting liquid; its constancy is great; and finally, the cost is merely nominal when the circuit is open.

AN IMPROVED FORM OF INDUCTION-COIL.

THE following particulars of a new coil constructed by Mr. Yeates may, says the *Telegraphic Journal*, not be uninteresting. The effects are remarkable, more on account of their production with a given length and weight of secondary wire than for any extraordinary length of spark. The results were obtained with a Grove's battery of five cells, (5 in. x 3 in.) The coil is wound in two junks, insulated by the interposition of an ebonite disk, in the manner recommended by Dr. Ferguson, by which the terminals of the secondary wire are both brought to the outside, one on each junk. The insulation is carried out, according to Mr. Yeates's plan, with gutta-percha tissue and paraffin. The contact-breaker is of the ordinary form, with a simple—though very important—contrivance for insuring a long contact; it consists in a considerable increase of the weight of the armature, and a due amount of elasticity in the spring that supports it, by which the momentum maintains contact during the greater portion of its vibra-

tion, a point which is not to be overlooked in the most effective construction of a coil.

The following are the dimensions of the principal parts of the coil: Core, 22 in. x 1¼ in. diameter; primary consists of two layers of No. 12 gauge copper wire; secondary consists of 55 layers of No. 36 silk-covered wire; 55,000 convolutions; measures 10⅓ miles, and weighs 10½ lbs. The condenser consists of 66 sheets of tinfoil (11 x 29) insulated with paraffin paper. With the battery already mentioned it gave 12¾ in. sparks in air, and pieces of ordinary plate-glass were readily pierced.

The following table contrasts the results obtained from Ruhmkorff's large coil (Ganot's "Cours de Physique") with that now under notice:

	Length of Secondary Wire.	Length of Spark in Air.	Length, per Mile of Wire.
Ruhmkorff's large coil...	62 miles.	17⅜in.	0.28in.
Mr. Yeates's coil.....	10⅕miles.	12¾in.	1.21in.

These results are in favor of Mr. Yeates's coil in the ratio of 4.3 : 1.

BATTERY IMPROVEMENTS.

M. BOUMAN, of Holland, has effected a considerable improvement in the arrangement of the Léclanché cell, rendering the pile still more constant. In the flat-bottomed glass jar a plate of gas-carbon and a rod of amalgamated zinc are placed vertically, a short distance apart. The intervening space and the sure rounding parts of the vessel are then two thirds filled with the usual mixture of coarsely pulverized cok- and black oxide of manganese. In order to prevent the zinc poles from coming into contact with the black mass, it is protected by a cover of woolen cloth. The porous cup is thus dispensed with. Léclanché made the connection with the carbon plate by means of a covering of sheet lead; but as this was liable to oxidation, a complete contact was often destroyed. Bouman remedies this evil by cutting a slit in the gas-carbon pole, and inserting a platinum wire, on the ends of which are clamps in connection with the outer circuit. Thus modified, the elements were found to run without interruption for a year sufficiently strong to drive an electric clock, and to sustain an alarm clock for two years. Mr. Higgs, by arranging a series of small-sized carbons and cylinders of zinc in alternate series, in a similar manner to the series of the old iron-zinc deflagrator, has been enabled to dispense with additional cells, at the same time evolving the full electro-motive force. He has succeeded in introducing into one small vessel twelve couples of zinc and carbon,

(adopting M. Bouman's method of surrounding the zinc with felt,) thus deriving the electro-motive force of about ten Daniell's cells from a very diminutive battery. Batteries exposing a larger surface are being made on the same principle. (26)

ELECTRIC CURRENTS BY BENDING.

P. VOLPICELLI.—The author summarizes the results of his experiments in the following points: All metals when being bent or twisted give rise to the development of an electric current, but copper exhibits this phenomenon in the highest degree. Lead, although not an elastic metal, also gives rise to the generation of an electric current, thus exhibiting an instance of the conversion of mechanical force into electricity; the electric currents thus produced are not perceptibly due to the development of heat due to the action of bending or twisting. When the bending is accompanied by the tearing asunder, or, rather, the distending, of the two ends of the metallic wire, a current is produced in an opposite direction from that obtained by putting the two ends nearer together; by increasing or decreasing the velocity of the bending, the intensity of the electric current is also increased or decreased. A metallic wire made of various metals soldered together produces, other conditions being the same, a less intense current by bending than when the wire is made of one and the same metal.

NEW GALVANOMETER.

M. BOURBOUZE, of Paris, is the inventor of a new galvanometer. It consists of a magnetized steel balance-beam, delicately poised and capable of being adjusted by means of sliding weights. This beam, which is inclosed in a coil of wire, is provided with a long pointer at its centre, and the end of the pointer passes along a graduated arc. This galvanometer is so delicate that it shows a considerable deflection when the hand is brought near a thermopile connected with it.

A current passing through the multiplier deviates the magnetic bar in the same manner as the lever of a balance would be affected under the influence of an unequal load in one of the scales; and further, as in ordinary balances, the magnetic bar carries at the centre a needle which passes over a graduated sector, allowing thus a means of ascertaining the extent of the deviation.

When the south pole of the magnetic bar is directed exactly toward the north, the disposition of the masses allow of obtaining at will any one of three equilibriums—stable, unstable, or indifferent. The sensitiveness of the

apparatus can also be made to vary in proportion to the nature of the experiment that has to be made.

The sensibility can be modified in another manner. By an arrangement similar to that adopted in hydrostatic balances, that is to say, by means of a rack and pinion, the balance, properly so called, may be raised or lowered. The mutiplier remains fixed; the variation of the distance of the magnetic lever from the centre of the multiplier produces a modification corresponding with the sensibility of the apparatus.

THOMSON'S SYPHON RECORDER.

WE give a *fac-simile* of a portion of a message received over one of the Atlantic cables, and recorded upon a ribbon of paper by Thomson's Syphon Recorder. The signals are similar to those made by the Refracting Galvanometer. The alphabet employed is the same as that used upon all the Morse, needle, and bell telegraphs in Europe, and is similar to that of the Morse Alphabet. When used in connection with the Mirror Galvanometer, where a spot of light is thrown from a mirror upon a shaded screen, a movement of a spot of light to the left indicates a dot and a movement to the right a dash. When recorded

upon paper by Thomson's Syphon Recorder, the upper points represent dots and the lower points lines.

The Syphon Recorder consists of a movable coil of very fine wire, supended between the poles of a powerful horse-shoe magnet, a syphon of extremely thin glass tube, machinery for moving a band of paper, an insulated vessel filled with common ink, and an electric doubler. The insulated vessel filled with common ink is placed in front of the coil. One end of the syphon dips into the vessel filled with ink, while the other end of the syphon is bent horizontally, and faces the paper ribbon. The syphon is so arranged as to be free to move in a direction at right angles to the length of the paper, and consequently, if the ink is caused to issue from the syphon with sufficient force, a line will be traced upon the ribbon, and if the syphon itself is moved from side to side angular lines will be made across the paper. If alternate positive and negative signals are sent through the cable the coil will be deflected from side to side, and will move the syphon by means of a

thread connecting them. The ribbon of paper being drawn forward by clock-work, the movements of the coil will be recorded on the paper. The spurting of the ink is necessary for the purpose of avoiding friction on the surface of the paper, and is effected by electrical repulsion, the ink-vessel being charged to a high potential by means of an electrical doubler driven by an electrical magnetic engine.

PROGRESS OF THE TELEGRAPH.

THE progress of the electric telegraph within the past six years has been very great in every quarter of the globe. Upon this continent the electric wire extends from the Gulf of St. Lawrence to the Gulf of Mexico to Panama, and from the Atlantic to the Pacific Ocean. Three cables span the Atlantic Ocean, connecting America with Europe, and another submerged in the Gulf Stream unites us with the Queen of the Antilles. Unbroken telegraphic communication exists between all places in America and all parts of Europe; with Tripoli and Algiers in Africa, Cairo in Egypt, Teheran in Persia, Jerusalem in Syria, Bagdad and Nineveh in Asiatic Turkey, Bombay, Calcutta, and other important cities in India, Hong Kong, and Shanghai in China, Irkoutsk, the capital of Eastern Siberia, Kiakhta on the borders of China, Nagasaki in Japan.

A direct line of telegraph, under one control and management, has recently been established between London and India, with extensions to Singapore, Hong Kong, Java, and Australia.

Europe possesses 450,000 miles of telegraphic wire and 13,000 stations; America 180,000 miles of wire and 6,000 stations; India 14,000 miles of wire and 200 stations; and Australia 10,000 miles of wire and 270 stations; and the extension throughout the world is now at the rate of 100,000 miles of wire per annum. There are, in addition, 30,000 miles of submarine telegraph wire now in successful operation, extending beneath the Atlantic and German oceans; the Baltic, North, Mediterranean, Red, Arabian, Japan, and China seas; the Persian Gulf, the Bay of Biscay, the Strait of Gibraltar, and the Gulfs of Mexico and St. Lawrence.

More than twenty thousand cities and villages are now linked in one continuous chain of telegraphic stations. The mysterious wire, with its subtle and invisible influence, traverses all civilized lands, and passes beneath oceans, seas and rivers, bearing messages of business, friendship and love, and constantly, silently, but powerfully contributing to the peace, happiness, and prosperity of all mankind.

THE ELECTRICAL DOUBLER.

THE purpose of the Electrical Doubler is to increase the least conceivable quantity of electricity by continually doubling it, until it becomes perceptible upon a common electrometer or is made visible in sparks.

The principle involved in the construction of the Doubler will be best understood by explaining the first device of this kind, invented by Mr. Bennet. This apparatus consisted of a circular brass plate three or four inches in diameter, polished and thinly varnished on the upper surface, upon which was placed another brass plate of equal diameter, polished and varnished on both sides, with an insulated handle attached to one end of it. A third plate was also provided, of equal diameter, polished and varnished on the under side, and with a perpendicular insulating handle extending from the centre of the upper side. Its mode of operation is as follows:

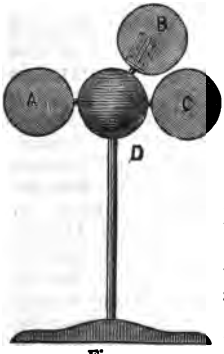


Fig 1.

Electricity is communicated to the under side of the first plate and the second plate is touched with the finger. The second plate is then removed from the first by its insulating handle and the third plate is placed upon the second. The third plate is then touched by the finger and then separated from the second. In this situation it will be apparent that two of the plates are charged with one kind of electricity, and of nearly equal quantity, and one of the plates with the other kind of electricity. The third plate is now touched to the under surface of the first plate, the first plate being covered by the second, and the second plate is touched by the finger. If now the third plate is removed, and the finger withdrawn from the second plate and the latter is lifted up from the first plate, the electricity becomes doubled. This process may be repeated ten or twenty times, and by doubling the quantity of electricity every time the smallest conceivable amount can be made visible, since at the twentieth operation it is increased 500,000 times.

In order to avoid the labor of the preceding operation, Dr. Darwin invented the movable doubler, consisting of four metallic plates moved by wheel-works, but requiring to be touched by the hand in order to produce the effect. This apparatus has been superseded by Nicholson's Revolving Doubler, which is represented by figures 1 and 2.

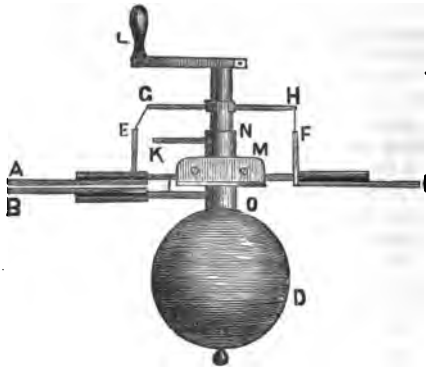
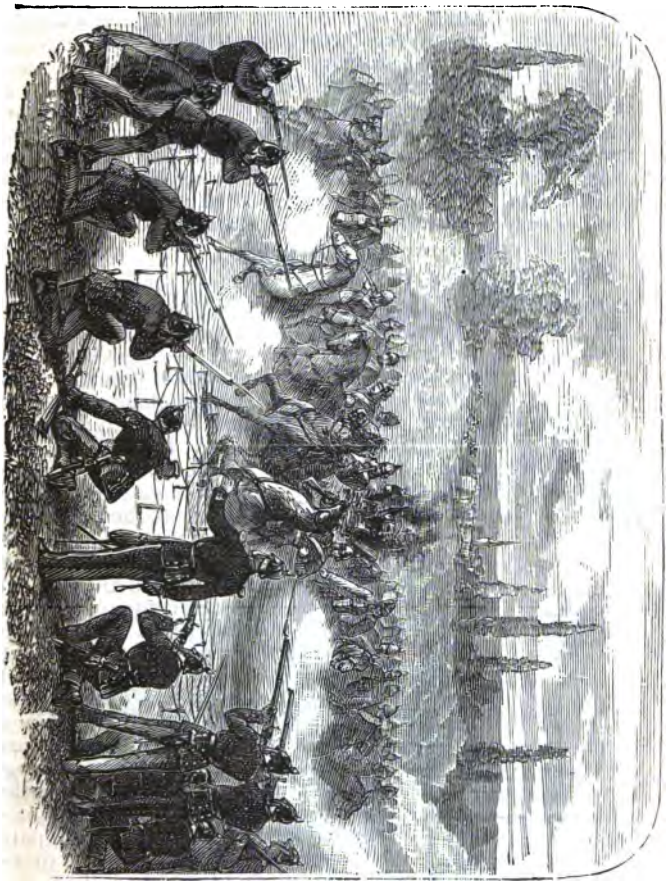


Fig. 2.

The instrument is supported on a glass pillar 6½ in. long, and consists of two fixed plates of brass, A, C, two inches in diameter, separately insulated and placed in the same plane, so that a revolving plate B may pass near them without touching. A brass ball D, two inches in diameter, is fixed on the end of the axis that carries the plate, B, and is loaded within at one side to act as a counterpoise to the revolving plate B, so as to keep it at rest in any position. The axis P O is made of varnished glass, and so are axes that join the three plates with the brass piece M, which supports the plates A and C. At one extremity of this axis is the ball D, and the other is connected with a rod of glass N O, upon which the handle L is fixed, and also the piece G H separately insulated. The pins E, F rise out of the back of the fixed plates A, C, at unequal distances from the axis. The piece K is parallel to G H, and both of them have their ends armed with small pieces of steel wire that they may touch the pins E, F in certain points of their revolution. In the piece M, there is fixed a pin I, which intercepts a small wire proceeding from the revolving plate B. These wires are so adjusted by bending that when the plate B is exactly opposite to D, the piece G H connects the two fixed plates, while the wire and pin at I form a connection between the ball D and the plate B. On the contrary, when the plate B is exactly opposite to the plate C, the ball D becomes connected with C by the contact of F with the wire at K, the plates A and B being then completely unconnected with any other part of the apparatus. In all other positions the three plates and the ball will be perfectly unconnected with each other.

DURING the recent rain-storm in New-York the wires of the fire-alarm telegraph became so loaded with ice that they broke down, and communication through the city was interrupted. It is now proposed to place the wires underground.

MECHANICS AND ENGINEERING.



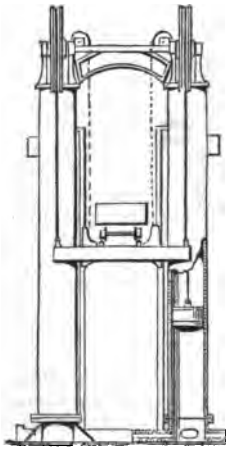
CAVALRY OBSTRUCTIONS.

THE Prussians, under the able guidance of Prince Bismarck and Count von Moltke, have not rested upon their laurels, but are continually improving and strengthening their affairs, both civil and military, or inventing some

new and formidable engine of warfare, or devising some successful and important army tactics. The latest of these is a new way in which to receive a cavalry charge, instead of forming a hollow square as formerly practiced. This is to spread a sort of network, or spider's web, of wires, fastened to stakes, which are driven into the ground in front of advancing cavalry, by which means the horses' legs are entangled, and the riders are put completely at the mercy of the enemy's infantry. This is only an improvement on the old Roman idea of a staked field, upon which the horses or elephants caught their feet and were brought to the ground. The French papers have taken up this new tactic, and discussed it with much irritation, but, at the same time, they advise its adoption.

PNEUMATIC ELEVATOR.

THE propulsion of railway-cars in tubes by atmospheric pressure has become a familiar operation. In the present example we have an illustration of the application of the same system to the vertical lifting of cars. The diagram shows the pneumatic elevator now in use at the Ayresone Iron-Works, England. The lift consists of a pair of iron air-tubes, in which a pair of pistons rise and fall, being actuated by air-pressure. Suitable ropes, passing over wheels at the top of the columns, connect the platform of the elevator with the pistons. In ordinary working, the loads to be taken up vary from 15 to 16 tons, and the balance is such that with this load an atmospheric exhaustion equal to about 6 lbs. per square inch is required in the tubes to lift the platform, while a plenum of about 4 lbs. per square inch is required to bring the platform down. The hoist is worked by a pair of engines having the cylinders inclined at an angle of 45°, the two connecting rods being coupled to a single crank at the centre of a crank-shaft which has at its ends a pair of opposite overhung cranks driving a couple of single-acting air-pumps, both of which exhaust from one pipe and deliver into another. These two pipes are connected to a casing fitted with a slide-valve, the arrangement being such that, by merely shifting this valve,



either the suction-pipe can be placed in communication with the cylinders of the hoist, and the delivery-pipe with the external air, or vice versa. The two cylinders of the hoist are placed in communication with each other by a pipe of rectangular section connecting their lower ends, this pipe measuring 6 inches by 12 inches inside, while from one of the cylinders a pipe leads off to the slide-valve casing already mentioned.

The hoist we have been describing lifts the wagons 35 feet, and with the four furnaces in full work, it will have to raise at least 6000 tons per week, this quantity being the gross weight of the material and trucks. Pneumatic elevators were introduced several years ago by Mr. Gjers, and they are now in use at a number of iron-works. They work very steadily, are controlled with great ease, and require a very moderate expenditure for maintenance, while their construction is such that working parts are at all times open to inspection—an important point in machinery of this class. (8)

THE DAVIES STEAM-HAMMER.

THIS invention is designed to replace the ordinary hand sledge-hammer for work upon the anvil, and is so constructed as to deliver its blows vertically, as in Fig. 1; obliquely, Fig. 2; or horizontally, Fig. 3. Its use is not restricted to ordinary blacksmithing, as it may be employed in machine-shops, or for forging rail road material, iron bridges, anchors, armor-plates of vessels, etc. The action of the hammer is entirely under the control of the operator, a simple movement of whose foot, acting upon the projecting arm of a valve, suffices to modify the direction and also the force and rapidity of the strokes. The machine, being movable upon its vertical axis, may be directed to operate upon four or more anvils and forgings arranged around it; the entire space occupied

Fig. 1.

by apparatus and anvils being less than that required by four ordinary steam-hammers, each with a single anvil. In addition to being readily adapted to work at any angle, the hammer can be arranged for any height of forging, so that the latter when once placed in position may remain fixed on the anvils, thus greatly economizing the time of the workman.

The hammer being surrounded by no framework, may be elevated in a few seconds to a height of nearly six feet above the floor, by means of a simple hydraulic jack; so that it may be easily adjusted to strike at any level. The exactness and certainty of the blows given render the machine much superior to the hand-hammer for the fabrication of bolts or pins of any diameter. It is also advantageously employed for the welding of plates, rails, or bars,

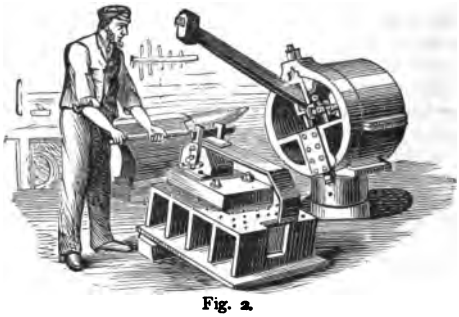


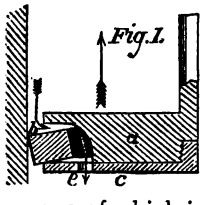
Fig. 2.

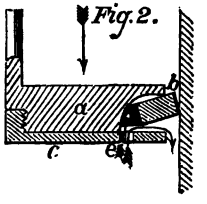
Fig. 3.

angle and T irons for bridges, etc., and in the construction of faggoted iron. As the work is done with great rapidity and the power applied to the best advantage, a large saving in fuel is accomplished. At the Viaduct Works of Crumlin, England, an establishment largely engaged in the manufacture of iron bridges, repeated tests of this device have proved that a single hammer is fully able to meet all the requirements of eight fires and one furnace.

NEW PISTON PACKING AND VALVE.

M. PAUL GIFFORD, of Paris, inventor of the well-known Gifford injector, has suggested the following simple devices for piston packings, applicable also to pistons which are to be close when moving in one direction, but which open like a valve when going in the contrary direction. Figs. 1 and 2 show sections of one half of a piston working within a cylinder, and represent the action of the piston when used as a combined piston and valve. Fig. 1 shows the piston in its rising motion. *a c* the piston, in the groove of which is an elastic ring *b*, which assumes an inclined position and permits the air or fluid within the cylinder to pass down as the piston rises. In Fig. 2, on the downward movement of the piston, the ring *b* assumes a contrary angle, and the contents of the cylinder are compressed. Thus in one direction the ring acts as a valve, and is so free as to diminish friction. When used only as a packing, the ring *b* is made somewhat thicker, and the steam or air entering within the inside of the ring presses it outward into contact with the cylinder.





THE FIRST TURKISH IRON-CLAD.

THE first iron-clad ever built in Turkey, the Moukademi-i-Khair, was launched from the imperial arsenal, at Hasskein, on the 28th of October. The Moukademi-i-Khair, or "Happy Being," is sister ship to the iron-clad Feti Bulend, constructed in England a few years ago for the Turkish Government, and, like that vessel, is built after the design of Mr. Reed, late Naval Constructor to the admiralty. She is fitted with Mr. Reed's central box battery, which enables the guns to fire on the line of the keel, and will mount four 250-pounder Armstrong guns. She is built entirely of iron and carries armor-plates six inches in thickness at the fore and after ends, and nine inches abreast of the engines and boilers, and on the sides and outer ends of the battery, all of which have been prepared in the arsenal under the immediate superintendence of Englishmen. The building of the vessel and the factories for the manufacture of the plating, etc., were under the

sole control of H. E. Ahmet Pasha, ably assisted by A'ali Bey. The keel of the Moukademi-i-Khair was laid on the 2d of October, 1869, and during the three years she has been building, about thirty-five English artisans have daily assisted in the principal parts of the construction. The cost of the hull, it is stated, will not exceed 108,000 Turkish liras, which added to £36,000 for the engines and boilers, stamps her value at £134,180 when ready to receive her armament on board.

AERIAL NAVIGATION.

THE propulsion of balloons by gas, drawn from the balloon itself, directed into a suitable engine, there mixed with atmospheric air and exploded by the electric spark, is suggested by P. Haenlein, of Mainz, Germany. The gas-engine operates upon the shafts of propellers, by which the balloon is moved and steered. One of the propellers, vertically arranged under the car, governs the rise and descent of the machine, and thus the use of ballast is avoided. One volume of gas and twelve volumes of air produce the necessary explosive mixture. The consumption of gas by the engine only amounts to three per cent of the contents of the balloon in ten hours. The cooling of the cylinders of the engine is assisted by the employment of a water-jacket, the water whereof is cooled by passage through a condenser which is fanned by an air-blower operated by the engine. Thus only a small quantity of water need be carried. Other cooling liquids may be employed in lieu of water. (8)

THE WASTE OF COAL.

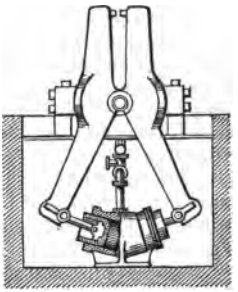
MR. SIEMENS, President of the English Institute of Mechanical Engineers, in his annual address at the convention of that society, held in Liverpool, asserted that of the total coal raised in England annually, from one half to two thirds, which might be practically economized, is now destroyed or dissipated carelessly, and that theoretically the coal consumed has more than ten times the capacity for iron-making and steam-production that is now practically realized. As a striking example, he stated that "sixty-eight pounds of coal is theoretically enough to bring a ton of iron to the welding heat, and more than enough to melt the same weight of cast-iron, the actual quantity consumed varying from ten to twelve to, perhaps, thirty times as much; in some instances even more."

He stated as an encouraging fact—proving that no real obstacles exist, practical or theoretical, to realizing a still vast economy in coal-burning for steam purposes—

that within the last nine years the consumption of coal per indicated horse-power has, in marine engines, been reduced by about one half. In fact, if the average marine-engine consumption of nine years ago is compared with the best results at present obtained, the improvement is far greater; for whereas the average was, as nine years ago stated before the institution, 4.5 lbs. of coal per hour per indicated horse-power, at present steamships make long voyages with a consumption not exceeding 2.2 lbs., and some but 1.7 lbs. of coal for the same duty.

HYDRAULIC PUNCH AND RIVETER.

A NEW punching and riveting machine, suggested by McKay and Macgeorge, of London, consists of a pair of jaws, operated at their lower extremities by hydraulic pumps, arranged as shown in the diagram. A very compact and convenient apparatus. (8)



STEAM AND VAPOR-ENGINE.

INSTEAD of using two separate cylinders, as is usual in the above class of engines, John F. Haskins suggests that one cylinder only be used, the steam operating on one side of the piston and the vapor on the other. He proposes to use a trunk-engine of such proportions that the upper or steam side of the piston shall have only one half of the pressure-surface of the under or vapor side.

BOILER-INCRUSTATION PREVENTIVES.

THAT method is best for general application which attains the complete removal, as well as prevention, of scale by chemical means operating inside the boiler.

Having this end in view, the writer has proposed two processes: one consists simply in the introduction into the boiler of a sufficient quantity of the oxalate of soda to cause the immediate decomposition of the scale-forming salts as they enter the boiler, converting them into insoluble oxalates, which are precipitated as a mushy sediment, which has no tendency to form scale, and which may be blown out from the mud-receiver, or otherwise voided. In the other process, tannate of soda is the agent, kept constantly present in the boiler in solution; it decomposes the carbonates of lime and magnesia as they

enter, tannates being precipitated in a light, flocculent, amorphous form, so that they do not subside at all in the boiler, but are retained in suspension by the boiling currents until they find their way into the same receiver, when they settle into a loose, mushy mass, which may be easily blown out from time to time. The carbonate of soda formed in the reaction is retained in solution, becoming a bicarbonate by appropriation of the free carbonic acid in the water. This decomposes the sulphate of lime, the resulting sulphate of soda being retained in solution, and the carbonate of lime being acted upon by fresh portions of the tannate of soda, as above. The constant presence of the alkali protects the iron from all action, either of the carbonic or tannic acids. The same reactions take place between the tannate of soda and the already existing scale with like results, but more slowly, some weeks being generally required, in practice, in removing the deposit, if it exists in any considerable quantity.

Portions of scale are detached, from time to time, which may be removed at the usual cleanings, which should be made at short intervals, when possible, until the boiler is entirely clear of all incrustation, after which this will not be necessary. Extensive practical trial of this process for two years has demonstrated its utility for all varieties of boilers. It is economical, easy of application, and generally adaptable. It may be used in marine boilers as well as those using fresh water, since the marine scale is almost identical with that formed in boilers using ordinary waters, consisting almost entirely of the carbonates of lime and magnesia and sulphate of lime. The chloride of sodium forms a mushy deposit, but is only incorporated in the scale to a slight extent.

STRENGTHENING IRON.

AN improvement designed to increase the strength of iron and other materials used for building and other purposes, suggested by W. Haggett, of Waterford, England, consists in preparing the material in the form of plain sheets and then corrugating the same, or, as he terms it, imparting an undulating form. The undulated sheets are then laid together so as to cross back and lock into each other in a variety of directions, at right angles, obliquely, etc. The undulated forms thus combined impart, it is claimed, great lateral strength and rigidity, and insure compensation for contraction and expansion. The methods of producing the undulations vary with the material used, some materials being cast into the desired forms, others rolled or pressed. In the

case of wrought-iron, the undulated plates are carefully fagoted together and then put through the usual welding process, whereby a very strong description of metal is produced. (8)

READING RAILROAD COAL-PIERS.

THE extent of piers and docks at Port Richmond, Pa., on the Delaware, belonging to the Reading Railroad, is, perhaps, but little known, except to those who have business in that section of the city. At this point can be obtained some idea of the enormous extent of the coal operations in Pennsylvania. The Reading Railroad Company owns a tract of land extending for more than a mile along the Delaware, and so rapidly has the business grown that extensions of docks and piers have to be frequently made. At the present time, the river frontage of shipping-piers amounts to 3000 feet. There are twenty-one shipping-docks, having a total length of 18,000 feet, the longest dock being 775 feet; and their width varies from 60 to 731 feet. These docks furnish at one time accommodations for 224 vessels and boats. The water in these docks varies from ten to twenty feet at low tide, with a tide-rise of six and a half feet.

In addition to the docks, there are 23 shipping-piers, the largest being 1172 feet, and the shortest 381. The total length of pier trestle-work is 20,212 feet, upon which is laid 10½ miles of single track; besides there are 22½ miles of track connecting with the piers. The coal-cars are provided with trap-doors in the bottom, through which the coal is passed down long shutes, 169 in number, and rapidly loaded in vessels. Although these piers and docks are not designed for storing coal, but simply for its rapid transit to the vessels, yet it sometimes happens, for lack of vessels, that the coal on its arrival must be stored. The capacity at this place for that service is estimated at 175,000 tons, which would make quite a respectable pile if dumped altogether.

The heaviest annual shipment from the piers was in 1869, when it reached the enormous amount of 3,500,000 tons; the heaviest weekly shipment was for the week ending September 3, 1870, the amount being 95,858, and the heaviest daily (28,000 tons) was August 31, 1870. The receipts of coal at Richmond on the last-named day reached to 18,600 tons, requiring 37 trains and 3722 cars to convey it to the Delaware River. There are connected with the docks 35 weigh-scales, used in the shipment of coal, with a weighing capacity of 25 tons each.

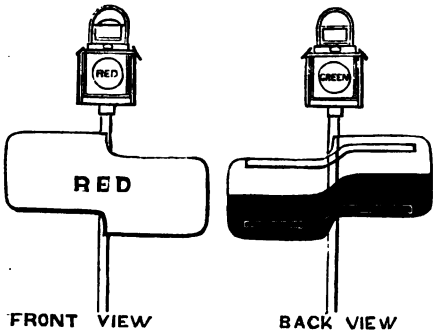
The company now owns as much more adjacent river-

front, which is reserved for the future requirements of the coal-trade. The large number of vessels arriving at the company's docks, and the handling of the coal, give employment to a large number of hands, reaching at times to over 1400 men. The company, in addition to bringing coal to Richmond by railroad, owns 83 barges for shipping coal to New-York by way of the Delaware and Raritan Canal, together with six iron steamers for delivering coal to eastern ports. (8)

CHANGE IN RAILWAY SIGNALS.

WITH a view to increase the efficiency of the distant signal in use on the Midland Railway, Eng., by enabling drivers, on sighting a distant signal, to distinguish by the shape of the signal, as well as by the color of it, whether it is applicable to the line on which they are running, or whether it is simply the back of the signal which is presented to them, it has been arranged that the form of the disk shall be altered and shaped as shown below.

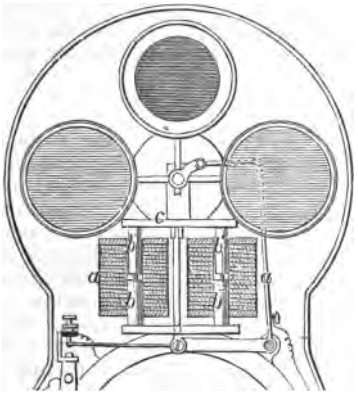
It will be observed that the disk consists of a high side and a low one, and the signal will be so arranged that, when turned on against an approaching train, the high side will always show on the left-hand side of the post as drivers approach it, and the low side on the right-hand side of the post.



Drivers will easily recollect that, as all semaphore signals are shown on the left-hand side of the post, so the elevated side of a distant signal shown on the left-hand side of the post indicates that the signal applies to the line on which they are running, while the low part of the signal appearing on the left-hand side of the post indicates that the back of the signal is toward them, and that it applies to the other line, and not to the one on which they are running. When the signal is at "all right," the board is turned edgeways so as not to be seen, and the lamp shows a white light. (8).

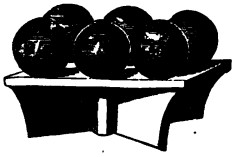
NEW RAILWAY-SIGNAL.

AN electro-magnetic signaling device for the use of railways, suggested by F. L. Pope, contains the following device: *a* the usual helices, *b b'* the soft iron cores, which are divided into separate parts, *b* being fixed, *b'* movable and attached to the armature *c*. When a current of electricity is sent through the helices, the axial magnetic force developed therein tends to draw the cores *b b'* into the helices, while at the same time both sets of cores are powerfully magnetized and their mutual attraction acts in conjunction with the first named force to bring them into contact with each other. The employment of the force of axial magnetism in this manner is stated by the author to materially increase the effective length of stroke in the apparatus. (8)



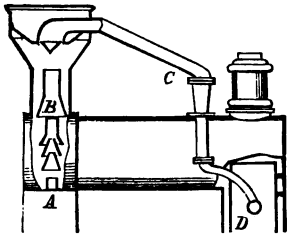
NEW RAILWAY-CAR SPRING.

A. H. KING has suggested the employment for car-springs of a series of rubber balls, which are arranged in iron boxes, either in single series, as shown in the diagram, or in double series, several balls upon each other. The peculiarity of this spring is, that the balls coming in contact with each other and the box at fine points only, it admits of instantaneous action when the load is increased or decreased, making the spring very sensitive and self-graduating. A great deal of the wear of freight-cars is caused by being run at high speed, when empty, on springs which are so rigid that they will not vibrate without a heavier load. The result is that the car is so shaken that the joints and nails become loose. It is claimed that an empty car will ride on the rubber-ball spring as easily as it will if partly or fully loaded. It also frequently occurs that a car is so overloaded that the springs are set, and cease to act except



when the wheels strike a rough spot, when the car is thrown up and comes down with a "thud," and the wheels and axles receive the full shock. The rubber balls have so much room to expand in every direction that they can not become a solid mass with any load which may be placed in a car. The balls will not rub or chafe, as the expansion and contraction of the rubber is above and below the points of contact. These springs are used on several roads in this country. (27)

LOCOMOTIVE IMPROVEMENT.



A SMOKE-CONSUMING Locomotive improvement, suggested by G. H. Griggs, of Whitestone, N. Y., consists in using the exhaust-steam blast *A* to drive the products of combustion, or the main portion thereof, through a compound blast-pipe *B*, and conducting-pipe *C* into the furnace *D*. In this manner that portion of the fuel which is now ordinarily wasted by escape from the locomotive chimney, is saved and burned, and the annoyance to passengers occasioned by the sparks, cinders, gas, etc., is in a measure prevented. (8)

SMOKE OF STEAMERS.

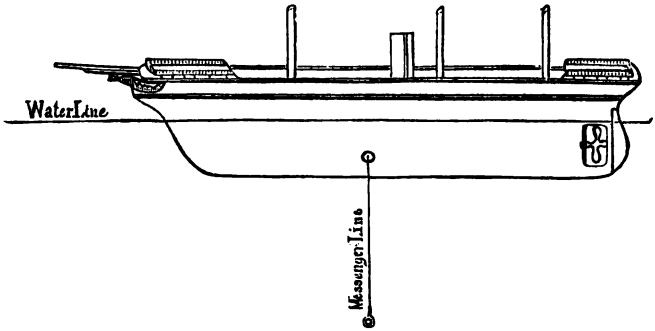
THE Austrian navy have made successful experiments for causing the smoke arising from the fuel consumed in steamships to be discharged under water by the aid of a blowing machine; at the same time a more active and regular combustion is obtained, and the chances of fire on board greatly lessened, while the funnel or iron chimney, one of the most vulnerable parts above-deck, is rendered unnecessary. The author has reason to believe that the experiments were in every respect successful.

SLAG AND ASPHALT PAVEMENT.

A NEW composition of slag and asphaltum is suggested by J. C. Tucker, of New-York City. Eighty parts of furnace-slag and twenty parts of asphaltum are used. The slag is first crushed, then heated and mechanically incorporated with the asphaltum, forming a homogeneous mass, which is then dressed into any desired form in moulds, or used as a pavement by spreading directly upon the ground and rolling the same. (8)

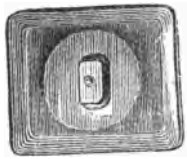
STOPPING LEAKS AT SEA.

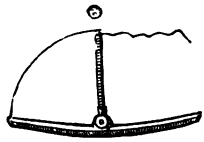
WHEN an iron ship springs a leak the greatest uncertainty usually prevails on board as to the safest and readiest means whereby she may be kept afloat. At first, pumping may serve; but with the rush of water, even through a rivet-hole, the size of the aperture increases, and at any moment the water may gain on the pumps and the ship sink. It is quite unusual that a vessel has the advantage of a diver on board, and not only has the leak to be discovered from the inside, but the patch on the outside should be applied in a firm and substantial manner, in any sea, from the interior of the vessel. Mr. McCool accomplishes this object in two ways. In either, dished plates are employed with a soft and water-proof packing, and as a rule a plate is applied on both outer and inner side of the aperture. The dishing has the advantage of strengthening the plates, besides insuring a tight joint at the strongest part of the ship's side around the leak.



The main point, however, is the application of these plates in any sea-way and under all circumstances, when once the opening has been discovered. This is effected by dropping through the hole a long narrow weight of lead or other metal, attached to one end of a cord or wire, the other end of which is secured within the vessel. The weight is then hauled on deck by means of a weighted grappling-line dropped over the bow, and drawn along underneath the vessel by means of cords, one at each side. The weight is then removed from its cord, and replaced by a threaded bolt or spindle, upon the outer end of which a metal plate with india-rubber or other elastic washer is screwed or otherwise fixed. The cord or wire is dropped overboard, and, by means of the opposite end, secured within the vessel, the bolt is drawn into the

hole so as to bring the outer plate in position. Another metal plate and elastic washer is then fixed to the bolt on the inside, and the leak effectually closed.





Another plan whereby the same object may be attained is by employing a bar of any required length, and not too large in diameter to pass through the hole to be stopped. To this bar, at or near its middle, one end of a threaded bolt is jointed. The bolt can turn on its joint so as to lie upon the bar or within a slot in the bar; and when the bolt is in this position the bar and bolt are passed through the hole in the vessel into the water. The bolt is then lifted by means of a wire, and the end drawn through the hole into the vessel, the bar remaining outside across the hole. An india-rubber or other elastic washer and a metal plate are placed on the bolt and screwed up tightly by means of a nut. There are various kinds of bars, but the principle never varies, and the outer bar acts as a stay or support for the ship's side, and insures a proper hold for the plates and packing.

The sketches show the line and weight dropped through the hole in the ship's bottom; also the threaded bolt and patch. (61)

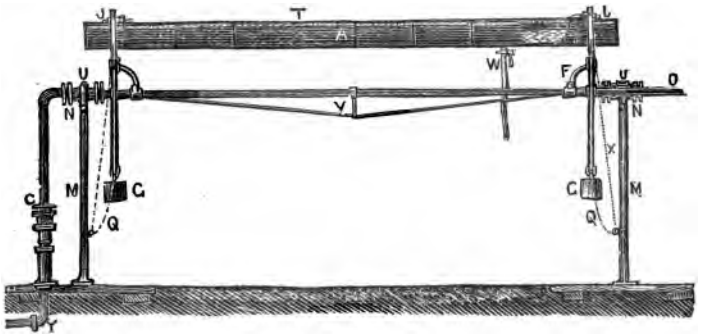
RAILWAY WATER-TROUGH FOR CATTLE.

In the accompanying engravings which illustrate Bonser's self-acting cattle drinking-trough, manufactured by Messrs. Ruston, Proctor & Co., of Lincoln, Eng., Fig. 1 shows an elevation of the apparatus, Fig. 2 being an end view of the latter as in operation.

It consists of a drinking-trough A, 14 in. wide and 12 in. deep, made of strong galvanized iron, riveted to round-edged angle-iron at the sides, the ends being formed of ¼ in. boiler-plate. The trough is attached to a hollow axis O, which is a strong wrought-iron tube 2½ in. inside diameter, and which revolves in double stuffing-boxes N N. These stuffing-boxes make a tight joint between the several lengths of tubing, they themselves being free to revolve in plummer-blocks U, and being carried by the cast-iron standards MM, which are bolted down to timber sleepers. The deflection of the hollow axis when the trough is down and filled with water, is prevented by the truss-

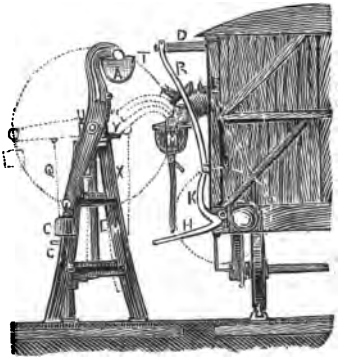
rod V, which is at right angles with the weighted levers G. The apparatus occupies a width of 7 ft. 3 in., and is to be erected the length of an ordinary cattle-train, with a main stop-cock C at the end nearest to the water-tank or reservoir. In working the apparatus, the train is drawn

FIG. 1.



up alongside the troughs, and the doors D in the upper part of the trucks (Fig. 2) opened by means of the hand-levers H. The water is then turned on at the cock C from the main Y, whence it flows through the pipe E along the hollow axis O, supplying all the troughs by the pipes F, which are of wrought-iron 1 in. inside diameter. The weight of water in the trough, overcoming the balance-weights G, brings the trough down to the position shown at P, Fig. 2, the descending troughs, by their own action, shutting off the water-supply by means of the hollow brass pivots J, which connect the troughs with the levers. A chain X attached to each lever prevents the trough ascending while the water is being consumed. When the troughs are full the water is shut off at the stop-cock C, and after sufficient time has been allowed for the cattle to drink, the waste-cocks W are opened,

FIG. 2.



and as the troughs become emptied of their contents, they will ascend to the position shown at T. The doors D are then lowered by the levers H, and secured by the link at L, when the train proceeds without delay. The truck-doors are further secured by self-acting spring catches, shown at S, one being placed at each end of the truck. The lever H is fixed on a spindle which passes through the bottom of the truck, and which has on each end a lever K jointed to a rod R, by which the door is raised.

CAR-VENTILATOR.

A NEW passenger-car ventilator consists of a series of fans, arranged to rotate or swing from the ceiling of the car, above the heads of the passengers. The fans are connected with the wheel-axles, and when the cars start, all the fans throughout the train are put in active operation.

REMOVING SNOW FROM RAILWAYS.

ACCORDING to an invention of C. T. Geslain, snow may be removed from railways, streets, etc., by pumping boiling water into a tank containing salt, and the hot brine so formed is discharged on the track through pipes connected with the salt-tank and terminating in sprinklers, which are located close to the tracks to be cleaned. The pump may be operated by an eccentric on the axle of the wheel of the car supporting the apparatus. (8)

LUBRICATING PACKING.

MESSRS. RAYMOND, DUNN & COLT have discovered that mica may be used for lubricating and packing machinery by heating and crumbling it, or by pulverization in its raw state. When so prepared, it is mixed with cotton, hemp, etc., and then used in lieu of the ordinary packing; and if mixed with oil or grease, it is said to make a good lubricant.

SECTIONAL BOAT.

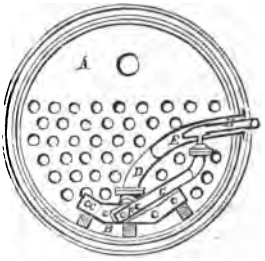
A BOAT made in sections which slide telescopically into each other has been devised by William H. Philip. By this arrangement the boat can be shortened up into the length of the middle section, for transportation, and as the sections are made tapering, tight joints are formed when the boat is drawn out to its full length.

ARTIFICIAL STONE.

HOFFMAN'S pulverized chalk one part, sand two to four parts, hydraulic cement one to two parts, with water. Expose to the air and sprinkle frequently with water. (8)

IMPROVEMENT IN LOCOMOTIVES.

HENRY W. ADAMS, of Philadelphia, Pa., is the author of a recent improvement, designed to improve the combustion of fuel in locomotives, and greatly reduce the cost of operating these machines. The improvement consists in the introduction into the fire-chamber of jets of air and steam which are formed at the base of the chimney-stack and carried back with force through the lower series of boiler-tubes into the fire. Exhaust-steam is employed to produce this backward blast. The combined air and steam blast impinges on the fire at a point just over the bed of burning fuel, and the author maintains that the blowing into and upon the fire of these jets, moving as they do in a direction contrary to that of the natural draught, has a tendency to detain the burning gases so that their caloric will have time to act upon the boiler surfaces, while the fresh supply of oxygen will cause a more complete and intense combustion of the fuel.



Our diagram is a vertical elevation, in part sectional, of the front end of the boiler and smoke-chamber. A, the boiler; B, mixing-chamber for the air and steam. The lower series of boiler-tubes C communicate with this chamber; the latter communicates with the open air by pipe D, in which an ordinary steam injector E is arranged, which, when the locomotive is running, is operated by exhaust-steam, which enters through tubes F and pipe G. When the locomotive is standing, live steam from the boiler is sent through the injector by pipe H. The author makes the following observations:

Combustion is distinguished by two degrees. Carbon, which constitutes a great part of the weight of wood and coal, is incompletely consumed when combined with oxygen so as to form carbonic oxide gas or smoke. This is the first degree of combustion. The binary gas resulting therefrom is composed of one equivalent of oxygen, united to one equivalent of carbon. In other words, six pounds of carbon unite with eight pounds of oxygen and produce fourteen pounds of smoke, or inflammable fuel, and set free a certain amount of heat.

Again, carbon is completely consumed when combined with oxygen, so as to form carbonic acid gas. This is the

second degree of combustion. This resulting gas is much heavier than the former; it consists of one equivalent of carbon united with two equivalents of oxygen, or six pounds of carbon combined with sixteen pounds of oxygen. This is perfect combustion. It disengages more than three times the amount of heat produced by the first degree of combustion.

The circumstances and values of these two degrees of combustion may be more precisely stated. They are well known to chemists, and are authenticated by trustworthy experiments, recorded in our standard scientific works.

One pound of carbon, consumed to carbonic oxide gas, the first degree of combustion, and the ordinary one, produces 2.66 lbs. of smoke, requires 1.33 lbs. of oxygen, which is equivalent to six pounds of atmospheric air, or a volume of 74.5 cubic feet. The combustion of this one pound of carbon, to this first degree of oxidation, disengages 4400 units of heat, evaporates 4.55 lbs. of water at 212°, and produces the motive-power of 1.72 horses.

On the other hand, one pound of carbon consumed to carbonic acid gas, or the second degree of oxidation, produces 3.66 lbs. of smokeless gas, requires 2.66 lbs. of oxygen, which is equivalent to 12 lbs. of atmospheric air, or a volume of 149 cubic feet. This combustion of one pound of carbon yields 14,500 units of heat, more than three times the first degree of combustion yielded; evaporates 15 lbs. of water at 212°, and produces a motive-power of 5.66 horses.

These facts present the immense importance of attaining the second degree of oxidation in the combustion of fuel. It shows that the major part of the wood and coal, as commonly used, escapes unconsumed from the smoke-stack of the locomotive, and vanishes in the air, and that the unceasing deluge of cinders, sparks, and smoke, which they belch forth into the atmosphere unutilized, represents an incalculable loss of money.

Besides this prodigal waste of fuel, clouds of smoke corrupt the air, a constant shower of charcoal dust, blown out of the chimney, falls upon the train, steals into the cars, soils and damages the apparel of passengers, and injures their eyes; while the treacherous sparks, leaping forth as if shot from a gun, by the impetus of the violent blast, ignite and consume millions of property.

Not less than seventy-five tons of coal, or cords of wood, out of every hundred tons or cords, consumed in the furnaces of locomotive boilers, are thrown from the top of the smoke-stack, under the impetus of the pumping suction of the blast, in the profitless and dangerous forms

of cinders, sparks, charcoal powder, carbonic oxide, and other unburned and noxious products of combustion. These unoxidized gases, capable of disengaging over three times more additional heat, pass through the tubes so quickly, and so rarefied, that they impart to it only a portion of their heat.

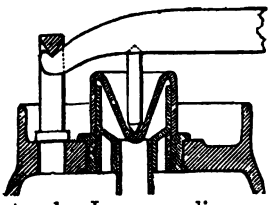
It seems to me that the true remedy consists in reducing the blast in the smoke-stack, and thereby relieving the pistons of the engines from much of their back pressure; in creating a more complete combustion in the fire-box, and thereby generating such an abundant supply of incandescent gases as to fill the combustion-chamber and tubes of the boiler with caloric of the highest intensty; and in causing the same, by a more moderate blast, to move more slowly and sluggishly through the tubes, so as to secure a better and longer contact of these vehicles of heat with their internal surfaces, throughout their entire length.

To attain this, a fresh and constant supply of oxygen must be poured into the combustion-chamber, to sweep across it, just above the burning fuel, and cut down the rising products of an incomplete combustion to a white, blow-pipe flame.

My improvement introduces a plentiful supply of fresh oxygen, injected in heated currents across the fire-box, in close proximity to the surface of the burning fuel, and contrary to the direction of the draught, by which means the products of combustion are pushed back toward the front end of the furnace, and prevented from entering the tubes before being consumed; the injected steam, by its instantaneous expansion, causes a perfect mixture of the air and gases in every part of the fire-box, and a longer time is gained for their complete combustion before leaving the furnace.

ROLTZ'S SAFETY-VALVE.

THIS is a form of safety-valve designed by Professor J. Roltz, of Prague, which is now in use in England. The valve-seat is connected by light radial feathers to a hollow cylindrical body having an external diameter equal to the internal diameter of the seat, and projecting above the latter for the height of 1⅛ in. Over this hollow cylinder the valve fits freely, the valve being itself cylindrical, with the lower edge coned to fit the valve-seat, and provided at its top—which is closed—with a conical depression for receiving the pin through which the pressure of the lever is transmitted to it. Finally, it will be observed that an iron pipe, of about 1 in. bore, is led downward from the



hollow cylindrical body on which the valve slides, this pipe extending down so far that its lower end communicates with steam, the pressure of which is unaffected by the blowing-off of the valve.

The action of the arrangement will be readily understood. In an ordinary valve, as soon as the latter lifts from its seat, there is a diminution of the pressure exerted on the under-side, and hence the height of lift is limited, not merely by the increase in the pressure of the spring-balance as the valve rises, but also by the reduction of the lifting pressure. In the case of the valve we are now describing, on the other hand, the full boiler pressure is exerted on the under-side of the valve, even after the latter has risen from its seat—the steam exerting this pressure being led into a hollow cylindrical body by the pendant pipe already referred to—and hence the height of lift attainable, and consequently the area available for the discharge of steam, is greater than with an ordinary valve. We understand that practical experiments made with this valve prove it to act most efficiently in preventing a rise of pressure in the boiler above that to which the valve is loaded, and the simplicity of the arrangement is a great point in its favor.

STEAM AND WATER GAUGE.

A CONVENIENT steam and water gauge for steam boilers has been invented by C. H. Hall, which consists of an inverted U-shaped glass tube, having one of its legs connected with the water-spaces, and the other with the steam-spaces of the boiler, by pipes which both extend below the water-line before they are attached to it. These pipes are fitted with three-way cocks at their junction with the glass tube, by means of which the air is emptied out of the pipes, and water takes its place in one and steam in the other. The steam soon condenses, so that the other tube fills with water also. By turning the cocks, communication is opened between the boiler and the glass tube, and the pressure of the steam condenses the air therein, and allows the water to show in both legs of the glass tube; and any difference in the height of the water in the boiler will be shown in the differing heights of the water in the legs of the gauge, whether the gauge be on the same level with the boiler, or at a distance, as in the cabin of a steamer or the office of a factory. Between the legs

of the water-gauge is another glass tube, closed at the top, and the pressure of the steam condenses the air therein, so that its varying height indicates the pressure in bounds on a graduated scale.

PORTLAND BREAKWATER.

THE completion of this magnificent work was inaugurated by the Prince of Wales in August last. The breakwater works commence with a pier, which starts from the island of Portland near the point where it is connected with the mainland by the Chesil Bank. This pier runs due east for a length of about 1900 feet, at which point there occurs an opening 400 feet wide, and having a minimum depth of 45 feet, to admit of the entrance of ships of war of the largest class from the southward. On the other side of this opening the breakwater proper commences, and is carried out to sea for a distance of 6000 feet from its starting point.

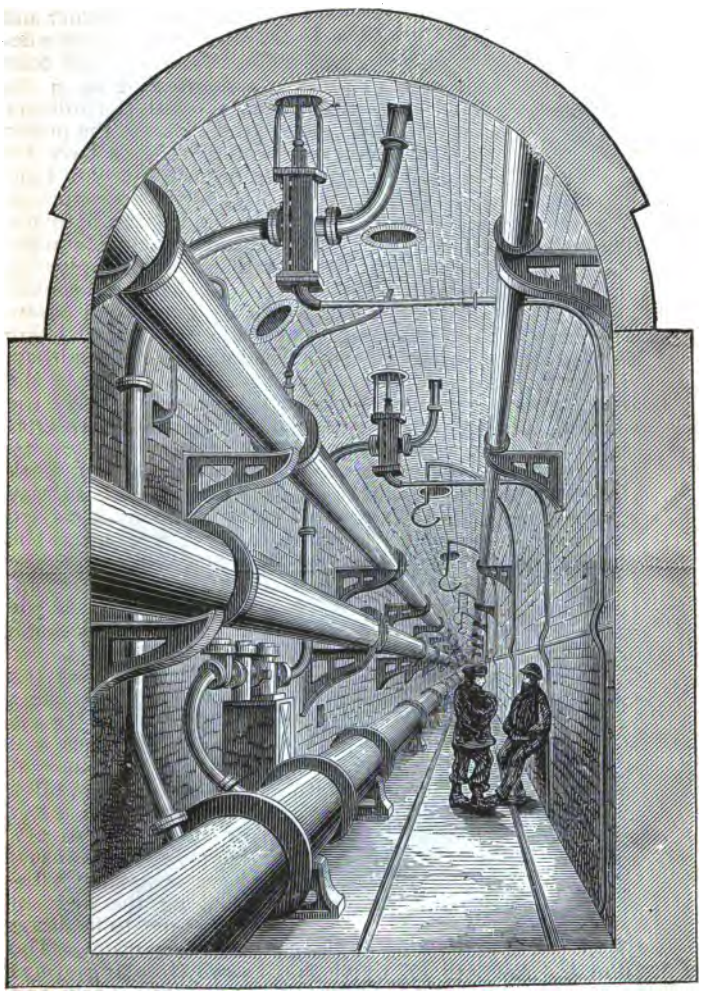
The pier, or inner breakwater, consists of a rubble mound, composed of stones of all sizes. After the mound had been consolidated, a trench was excavated within it to the level of low water at spring tides, and a wall of masonry was erected therein. The face-courses of this wall, up to 6 feet above high-water level, are hewn granite. The sea-wall is strengthened by counterforts, 20 feet apart, and connected by arches, so that a platform is obtained 15 feet in width, exclusive of the footway and the parapet. The breakwater proper is simply a rubble bank, the material of which it is formed being for the most part the "capstone," which covers the valuable Portland stone, but which of itself is valueless, except for this purpose.

The total length of the whole work is about 1⅛ miles, the width of the structure at the base being 300 feet, at low-water level from 90 to 100 feet, and at the top 60 feet. The average height from the bottom is 70 feet. The sheltered area afforded by these works is about 2100 acres in extent up to low-water line. Connected with the works are two forts, an inner and an outer one, placed one at the end of the pier and the other at the end of the breakwater proper.

MAKING STEAM.—W. F. COX proposes to draw down a portion of the heated gases arising from the fire in boiler furnaces and mix them with the exhaust from an engine, so that the steam becomes decomposed, and is then passed under and through the fire to promote the combustion of the fuel therein.

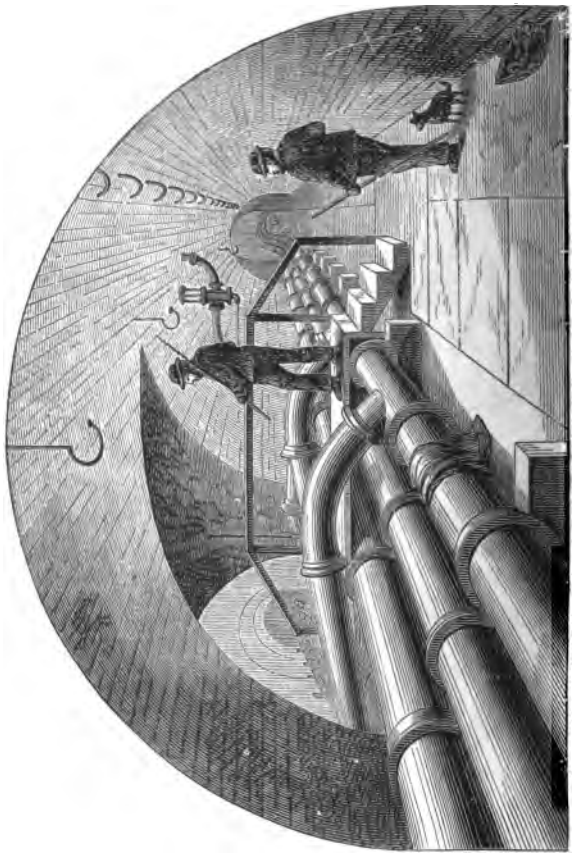
HOLBORN VIADUCT SUBWAYS.

IN the construction of the Holborn Valley Viaduct and the streets connected with it the corporation of London determined to introduce subways for gas, water, and telegraph pipes, and thus to prevent the breaking up of the road surface, which is so often necessary with the ordinary system of placing them in the ground beneath the public way. As a means of conveying water, subways have for some years been used in Paris, and more recently in London. They were first introduced here in the construction of Southwark street, from Blackfriars road to the Borough. The conveyance of gas, however, requires special arrangements for ventilation to prevent the risk of explosion, and the subways under the Holborn Viaduct are believed to be the first constructed with a view to their safety when used for this purpose. The arrangements must here be explained. In the Holborn Viaduct there is a subway, 7 feet wide and 11 feet 6 inches high, on each side of the road, running between the great arches which carry the roadway and the house-vaults which support each footway. The subways are immediately above the sewers, and are well drained, floored with large slabs of York stone, and lined with light gault bricks. In each subway a 14-inch main pipe of the New River Company is carried by iron chains near to the wall nearest the frontage of the houses, and above it 10-inch gas-mains, belonging to the City of London and Great Central Gas Companies, are supported on iron brackets projecting from the wall; on the opposite side of the subway a pipe containing the telegraph wires is carried in a similar way. All the pipes are so fixed that workmen can easily examine and repair the joints; and, in anticipation of the new buildings, junctions with the gas and water-pipes have been made for each house; from these junctions the pipes will be conducted through holes formed in the sides of the subways and communicating with the house-vaults. Branch pipes are laid on from the subways to the street watering posts, and to the fire hydrants in the streets, and gas is laid on to the street lamps. All the usual valves, meters, and other apparatus are accessible within the subway itself. Rails are laid along the floor of each subway, on which runs a traveling crane, to facilitate the removal and fixing of the gas and water-mains. The subways are ventilated by means of small circular gratings fixed in the footways along the centre of each subway, and by flues which run up the party-walls of the houses and terminate above the roofs. Every street-lamp and every post along the edge of the footways communicates also



HOLBORN VALLEY VIADUCT—SECTION OF SUBWAY ON EACH SIDE.

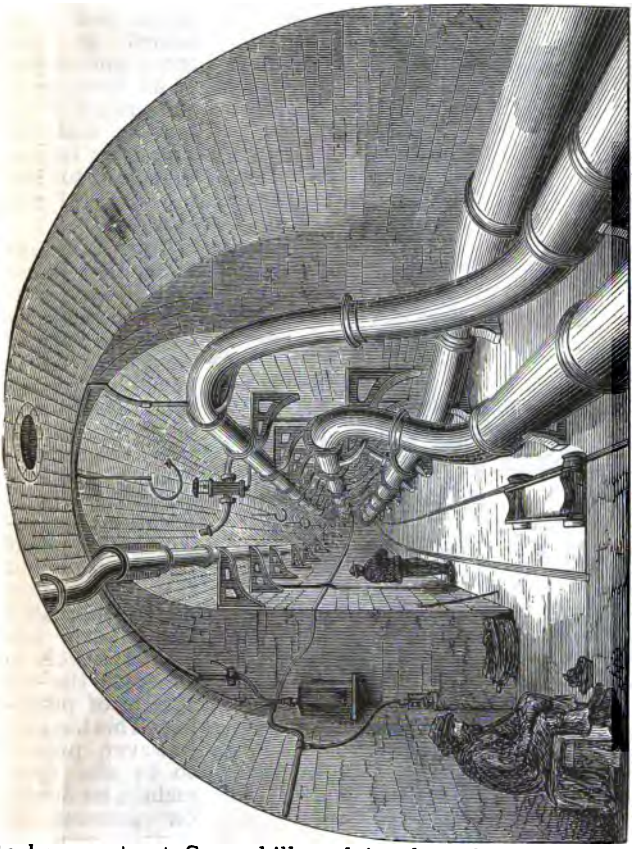
with the subways, and is so perforated as to act as an efficient ventilator. Wherever practicable, the doors of entrance are also constructed of open iron-work. Hitherto the ventilation has been perfectly efficient, and no



SECTION OF LONDON SUBWAY—NORTH SIDE, JUNCTION OF CHARTERHOUSE STREET.

danger is apprehended from the use of naked lights or from the gas-jets by which the subways are lighted at times of inspection. One portion of the viaduct subways, between Farringdon road and Shoe lane, has been lighted by means of Hyatt's patent vault light, an American invention introduced into this country by Mr. Haywood, the

engineer of the Commissioners of Sewers, who designed the Holborn Viaduct. It consists of a large frame of cast-iron, glazed with thick bosses of glass, let into the footways at intervals over the crown of the arch of each subway, forming a very efficient means of lighting. In Char-

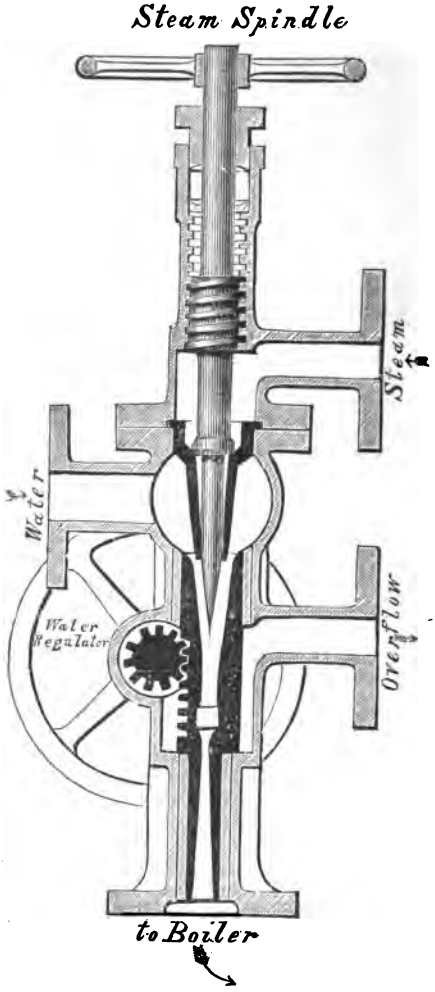


SECTION OF LONDON SUBWAY—SOUTH SIDE, AT WEST END OF VIADUCT.

terhouse street, Snow hill, and in the other subsidiary streets there is but one subway, of a lower form, 12 feet wide and 7 feet 6 inches high, running under the centre of the roadway. In these the pipes are laid on dwarf walls along each side of the central pathway. In all other respects the arrangements are as nearly similar to those already detailed as the circumstances would allow.

GRESHAM'S IMPROVED INJECTOR.

THE supply of feed-water to boilers and steam-generators, in due and adequate degree and temperature, to replace regularly and efficiently the water removed by evaporation into steam and consumed by the steam-engine has at all times been the subject of attention, and afforded an important field for the ingenuity of the inventor.



The Giffard injector first introduced and utilized the important principle of employing the exhaust-powers of a steam-jet to inject feed-water into the boiler, thereby dispensing with the complications and inconveniences of pumps, etc.; and this invention might reasonably have been expected entirely to supersde the old system of pumping. This has not, however, proved to be the case, mainly, no doubt, on account of certain countervailing defects.

We illustrate herewith an improved form of injector which possesses many

special advantages in arrangement and construction, made by the firm of Heron, Gresham, and Craven, of Manchester, England.

The drawing is an elevation of an instrument adapted for the supply of locomotives, where the injector is placed above the level of the foot-plate, or for the supply of stationary or marine boilers where the feed-water is taken from a cistern below the level of the injector.

The steam spindle is made much stronger than usual, to obviate the liability of the needle getting bent, which has been such a source of trouble, hitherto, in the smaller sizes. All internal packing is dispensed with, and the stuffing-box on the steam spindle is fitted with a gland, secured by two bolts and nuts, which overcomes the liability to work loose, as it is found to do when fitted with a screw-cap.

The steam-spindle is also fitted with a valve which has a seating on the top of the steam-cone, and prevents the bursting of the nozzle by the spindle being too tightly screwed down.

The combining cone works in a brass bush, accurately fitted, and the wheel of the water-regulator has an index which is so graduated as to show at once the degree of opening necessary for varying pressures of steam.

It will be seen that there is no stuffing-box used, and that the bearing surfaces can be tightened up by means of a back nut. The regulating wheel is placed at the side, thus avoiding any inconvenience in case the steam-joint should leak.

The great advantage of the Gresham improved injector consists in ease of starting and its being adapted for use within a great range of steam pressure; whereas in most of the older forms the pressure for which they were nominally made and supplied admitted of but slight variations, over or under, except by continuous and troublesome adjustment. (74)

CAR-WHEELS.

A NEW style cast car-wheel has been suggested by John Sax, in which the inner portion is made of soft iron, for strength, and the outer portion of hard metal, to make the tread more durable. The wheel is cast in an ordinary mould; but, to keep the metals from mixing as they are poured—both being run in at the same time, in different places—a metal ring is set in the centre of that portion of the mould in which the tire is formed, which ring remains in, and forms a part of the wheel.

VELOCITY OF CANNON BALLS.

A VERY ingenious instrument, known as Noble's chronoscope, is used for measuring the velocity of shot during its transit through the gun. The tube of the gun is fitted inside at certain intervals with metal rings (to the number of six or eight,) the outside margins of which are sharpened into knife edges. As a shot passes along the tube and through these rings, the edges of the latter are jammed down upon, and made to cut through, the ends of various insulated wires, one of which is placed under each ring. Each of these wires is connected with an electric battery, and, as one wire after another is cut through, and the insulation removed, an electric current passes, and a number of electric sparks follow one after another, according to the number of rings and wires. The recording of signals is accomplished by means of a series of metal disks, one in connection with each, which are made to revolve at a certain known velocity. The surface of the disks is of polished silver coated with lampblack. As soon as a wire is cut by the passage of a shot, a spark hops over to the recording disk, removing a little of the lampblack coating, and thus marking the place by leaving a bare minute spot of bright metal. From the relative position of the successive spots on the disks, and the known velocity at which they revolve, a simple calculation determines the velocity of the shot. A shot usually takes from one two-hundredth to one three-hundredth of a second to traverse the whole length of the bore of a large gun, its speed being somewhat slow when passing the rings, and increasing as it approaches the muzzle of the gun. From the extreme delicacy of the instrument, the calculation can be made with precision to a millionth part of a second, and the velocity determined with the greatest accuracy.

STEAM-GAUGE ALARM.

TO enable the overseers or superintendents of factories to know if the engineer examines his water-cocks at proper intervals, H. Pieper proposes to connect the middle cock with a clock movement having an alarm, so arranged that if the engineer fails to turn the cock at least once in a certain defined period, the time movement of the clock will stop, and an alarm will be given. The trying of the cock at any time will not interfere with the movement of the clock or alarm, except to keep the time movement in motion and prevent the alarm going off.

CAR BRAKE SHOES.—It is stated by J. J. Torley that by the use of malleable cast-iron for brake shoes a much better rubbing surface is obtained, and the "dead weight" is reduced.

ASPHALT PAVEMENTS.

ASPHALT pavements are now extensively used in London and Paris, and they are undoubtedly the best of any form of pavement for city use that can be adopted.

In snow or frost, asphalt is not so slippery as granite, being in itself warmer, and also more easily warmed by the slightest rays of the sun; hence, the ice is more slow in forming, and quicker in melting, than on granite.

The conclusions that have been arrived at by the experience in London are:

1. That the prime cost of the asphalt is the same as that of a granite pavement.

2. That with the present prices, the annual cost of maintenance is a trifle greater than the granite.

3. That, at the end of seven to ten years a granite pavement is worn out, whilst the asphalt is still in perfectly good condition.

4. That the asphalt, when taken up, may be always used again for the same purpose or for mastic.

The experience in Paris shows:

1. The asphalt costs, in the first instance, one-third less than the stone pavement.

2. That the annual cost of maintenance is three-quarters less than that of macadamized roads.

From these facts it will not be difficult for any municipal authorities to deduce the great advantages of the asphalt pavement.

M. A. Merian, the engineer of Basle, Switzerland, conceived the idea of laying down powdered asphalt in a warmed state on the street, and applying a strong pressure, so as to form at once an impermeable elastic surface.

The French engineers soon followed the example of M. Merian, and although they can not dispute the right of the Swiss to the first invention, yet they may claim for France the honor of having taken the lead in every useful application of asphalt.

The following is the process of preparing the asphalt pavement, as described by M. Léon Malo:

"The asphalt stone is brought direct from the quarries, and broken up into small pieces about the size of those used for macadamized roads; it is then heated over a stove, in a drum-shaped iron vessel with feet, till it crumbles into powder; and in order that the powder may not lose its heat, the whole apparatus is conveyed on to the street where it is to be applied. Then a foundation of 'béton' is laid, about four inches deep, which may, however, be thicker or thinner according to the nature of the soil."

On some ground—a road which has been macadamized, for example—the substratum of concrete may even be dispensed with entirely, whilst on a loose soil it may be made as thick as six inches. When the béton has hardened, and been cleaned, it should be smoothed to the proper curve. The arch of the roadway ought not to be greater than is absolutely necessary to drain off the rain-water, in order that the horses may not slip on the incline at the side.

The powdered asphalt is then spread over the surface, to a depth of one and a half to two inches, (according to the amount of traffic it is to bear,) and stamped down; a roller of 2500 to 3000 kilogrammes' weight is then drawn over it, to make the pressure perfectly even. Two hours later the road is ready, and may be opened to carts and carriages. This pavement has been in use in Paris since 1852, where some fifty miles' length of it has been laid.

IMPROVED WOOD PAVEMENT.

By Flanigan & Winser, of Detroit, Mich.—In putting down this pavement, the street is first graded in any of the well-known methods, and the earth made compact by tamping or rolling. Upon this roadbed is laid a concrete foundation, composed of broken stone, sand, or gravel, thoroughly mixed and bound together with concrete composition, the cementing material of which is chiefly Trinidad asphaltum. Upon this foundation are placed, on end, cylindrical blocks of natural wood, (the bark removed,) cut from young trees or saplings of small diameters, (say from three to nine inches.) Cedar, chestnut, and cypress trees of commonly small growth can be utilized in this pavement, with, it is claimed, less liability of decay than pine, hemlock, spruce, or other woods, mostly used in other wood pavements. The irregularities of the natural wood prevent vertical displacement, and make the pavement stronger than when sawn blocks with parallel sides are used. The spaces between the blocks are filled with dry gravel or broken stone, and filled flush to the top with the hot melted asphaltic composition, which cements the blocks together and firmly to the foundation, making the roadway one solid mass impervious to water. The top of the pavement is then covered with the asphalt composition in which, when warm, is rolled coarse sand or grit, so that the water will be kept out, and the wood protected from wear. It is claimed that in this way a very high degree of durability is secured.

It is further claimed that the practically indestructible foundation, giving additional firmness to the roadway, entirely prevents frost under the pavement, and that the

blocks and concrete filling are cemented to the foundation with a bond so perfect that the pressure is divided over large areas, preventing portions from sinking under heavy travel, and the surface from becoming uneven and "wavy," as occurs in some other pavements.

It is stated that actual experiments show that a moderate amount of excavation will not disturb the pavement. It seems obvious that pavement made from wood of about the same size and growth will wear much more evenly than that made from trees of various sizes.

We are told there were about 40,000 yards of this pavement laid in Detroit last season, and that it is considered a success in that city.

MOSAIC PAVEMENT.

THIS material, made by female convicts, is found to have many advantages over the ordinary tile pavement, and is being extensively used in the South-Kensington Museum, London, where the name *opus criminale* has been applied to it. It is composed of refuse marble, such as is thrown aside in marble work. The mode of manufacture is as follows: The pattern which it is intended to produce is traced on a board or on paper placed on a table, and inclosed within a frame. The fragments of marble are then chipped into pieces of a suitable size and shape, and are laid close to one another on the pattern which has been prepared, the various colors or shades of the pattern being followed by marble of corresponding color or shade. A layer of cement is then placed over the layer of marble, and of course penetrates the interstices between the fragments of marble, and this cement may, if necessary, be strengthened by a tile laid in the middle of its thickness. The mosaic tile thus formed is then taken to dry, and when this process is completed, it is returned to the workshop to be faced. Until this part of the process the tile has been laid on its face, but now it is laid on its back, as it will appear when in position as a pavement, and the worker, with a piece of York stone, proceeds to rub it down, until the whole surface has been brought to a level and is sufficiently smooth ; any inequalities which may have arisen from too great irregularity in the marble fragments are now corrected by removing the imperfect pieces and replacing them. It is found that after a little instruction, a woman can perform each of these stages of the manufacture at the following rates: Setting, .99 ft. per diem; cementing, 9.44 ft. per diem; facing, 1.80 ft. per diem.

The preparation of the patterns is, of course, the work

of a foreman or instructor, and the designs may be furnished by an artist, as in the present instance. Floors have also been made of cement, with fragments of marble interspersed irregularly—a useful manner of employing such small chips of this material as can not be made use of for the mosaic, and suitable enough for floors where the traffic is only light.

IMPROVEMENT IN STREET-WATERING.

AN official trial lately took place at Hyde Park Corner, Knightsbridge, England, of the system for watering streets, public parks, and market gardens, patented by Messrs. Isaac Brown & Co., Edinburgh. The patented apparatus was shown upon the drive at the east end of Rotten Row, Hyde Park, and upon one of the large inclosed flower-plots, which has been fitted with it by order of Mr. Ayrton, her Majesty's First Commissioner of Works. In one of the illustrations of the new mode of road-watering, one and one half inch lead pipes are laid along close to each curb-stone, these subordinate pipes being supplied from the mains. At intervals of about two feet apart, the pipes are drilled with small holes of from a sixteenth to a thirty-second of an inch, in groups of three, each of which is pierced at a different angle. These apertures from the pipes command the complete road, which at the place where they are exhibited is about nineteen yards wide. The water is, of course, supplied under pressure, with a head of about 100 feet, and a shower of a quarter of a mile in length can be commanded with a one and one half inch pipe. The other experiment for road-watering was by a central pipe in the middle of the road, which throws its jets toward the curb-stones. The pipes are protected by shields, and provision is made for the surface water being sent past the sides of the pipe to the bottom, where it finds a passage. The central pipe is of course upon the crown of the road, and is protected by an asphalt covering. An apparent objection may be that the small apertures may get choked up by the *débris* of the roads. In practice, however, this is found not to be the case, as the pressure of the water, when it is put on, keeps the drilled holes open. In winter, when there is the danger of freezing, the watering-pipes are kept empty, which is not found to be a matter of much practical difficulty.

GRINDING RAILS.—It has been suggested by J. A. Woodbury that much of the wear of rolling-stock is due to the unevenness of the rails, and that this may be remedied by passing them over a table above which a grindstone is revolving, thereby grinding their faces perfectly true.

STEAM STREET-CARS.

DURING the past year several improvements have been perfected, having in view the application of steam-power to the driving of city street-cars as a substitute for horses. Prominent among these is the Remington car, made at Ilion, N. Y., under the patents of William Baxter. Our engraving is from a car which was used last fall on the Bleecker-street line in New-York City, during the prevalence of the horse distemper.

In outward appearance, the car differs but little from the ordinary street-car. In the space ordinarily used as a doorway stands a compact boiler and engine. All the machinery does not occupy more space than an ordinary parlor-stove of the larger size. The engineer stands upon the platform, occupying the place of the driver.

The engine, by William Baxter, is made on the compound principle. It has two cylinders, and drives the car

by direct crank connection, without any intermediate mechanism. The steam is admitted from the boiler to the first cylinder, which is smaller than the other, and which is, in fact, a "high pressure" cylinder. It escapes from this to a chamber formed by a jacket around the boiler, where it is superheated, and then it is used in the larger cylinder. As it finally escapes, it is reduced to about atmospheric pressure. By this means the entire force of the heat is used, and ecomomy of fuel as well as of space for the boiler is obtained. The engine is arranged to consume its smoke, and with the low pressure of the exhaust both soot and noise are avoided. The engine, as ordinarily run, is a five horse-power engine, and will take a load of thirty or more passengers over a reasonably level track at the rate of fifteen miles an hour, at least. The engineer can instantly and at pleasure throw the steam from the boiler directly into both cylinders, and give his engine, for the time, twenty-five horse-power. It thus takes its load easily, and without retarding its speed, up grades of four hundred feet to the mile. It is, in fact, a five horse-power engine, with power to increase its power five times, without stop and without loss of speed. Having no gearing, cogs, or intermediate mechanism between the engine and the crank of the drive-wheel, there is comparatively no danger from disarrangement in that quarter. The outer jacket of the boiler is shut in from the body of the car by a wooden screen, through which no heat passes at any time. The exhaust in the summer goes under the car. In the winter it is taken through the car by pipes, which give moderate but equal temperature to the atmosphere. Mr. Baxter has embodied in this engine another feature, by which the objections of reversing the engine are entirely done away. Running at the rate of six miles an hour, he stops the loaded car in eight feet. Going at the rate of twelve miles an hour, he stops in thirty-two feet. The great economy in steam gives equal economy in fuel, so that coal is consumed at the low rate of one ton to the thousand miles. As nothing precedes the car, all the windows can be opened, without trouble from dust. Smoke, there is none; there is nothing to raise dust except the car itself, and what dust it raises is under the car and left behind.

The use of the car in the city was a decided success. The Bleecker-street track is one of the most difficult in the city, many of its grades being very heavy and its curves very short. But the Remington car passed over them with great ease. The engineer had complete control of the car in every respect, graduating the speed, stopping, or starting with the utmost precision.

THE FIRELESS STEAM STREET-CAR.

In this connection it may be interesting to give more particulars of the ingenious application of steam-power to street-cars, designed by Dr. Émile Lamm, of New-Orleans, La., in which he dispenses with the use of fire upon the car or locomotive. This is done by charging the car-boiler with highly heated water at the station previous to starting the car.

This invention has been put into practical operation at New-Orleans, La., where a company, of which Gen. G. T. Beauregard is president, is engaged in its perfection and introduction.

The boiler is made of steel, and is well covered with non-conducting material to prevent the radiation of heat.

Inside, from end to end, near its bottom, runs a pipe which is perforated with numerous small holes in its periphery, and which is connected with a universal coupling attached to the front of the reservoir. It is also provided with a water-cock, etc., steam-drum, and proper steam-connections with the engine. The operation of the apparatus is as follows: By making suitable connections with a stationary steam-boiler, the car-boiler is first heated throughout, and then a sufficient supply of water of the requisite temperature is forced into the reservoir. When properly charged, the water is flush with the water-cock, and its temperature is about 380° Fahr., the steam-pressure being about 170 lbs. to the square inch. The car is then ready to be started on its trip, there being sufficient power stored up in the boiler to enable it to run the car a distance of nine miles without expending the whole of it. Before beginning the next trip, the charge of hot water is renewed by again coupling the car-boiler with the stationary boiler, from which steam is forced in for about four minutes through the perforated pipe; by which operation the temperature and pressure are restored, and the water which went off in the form of steam during the previous performance of the engine is replaced.

The rationale of the foregoing need not be dwelt upon. Suffice it to say that, in obedience to well-known laws, as the pressure within the car-boiler is relieved by the passage of the steam into the engine, a portion of the water in the former is converted into steam by the heat with which it is surcharged. This conversion would go on until the temperature in the remaining water had fallen to 212°. It is calculated that with the boilers as now used, about fifty gallons of water is converted into steam before this point is reached. The steam given off develops sufficient power to make a nine-mile trip easily, and leaves a

pressure of 60 pounds in the car-boiler at the completion of such a journey.

The absence of danger of explosion in using this apparatus is apparent, and it is real also. The pressure in the reservoir can never rise above the point reached at the time it is charged; and after that it is necessarily continually diminishing as the power is expended.

Among the advantages attending the use of this improvement, is the absence of all danger of explosion, a difficulty that has always attended the use of steam-cars in crowded streets of a city. The public have not looked with encouragement upon the use of thousands of fires in the streets, and the attendant risks of explosions. But in respect to the fireless steam-car of Dr. Lamm, no such objections can be raised, because the steam-pressure is, from natural causes, always diminishing, and no fire is employed, by which alone it could be increased.

The comparative economy of steam over horse-power may be gathered from the following estimates:

CAPITAL INVESTED IN HORSE-CAR.

First-class car	$1000
Eight horses at $175 each	1400
Eight sets of harness at $30 each	240
Food, stable accommodations, etc., for eight horses at $5 per week for fifty-two weeks	2080
Shoeing eight horses at $5 per month, $40 for twelve months	480
Conductor, per annum	900
Driver, per annum	900
Total	$7000
Interest at 7 per cent	490
Wear and tear on car, $1000; horses, $1400; harness, $240; total, $2640, 25 per cent per annum	660
Total expense of horse-car	$8150

CAPITAL INVESTED IN DUMMY ENGINE.

First-class car and dummy engine	$4000
Expenses of coal, equivalent to work of eight horses, 60 cents per day, per annum	219
Water, 7½ cents on 100 gallons, 50 gallons used per day, per annum	15
Engineer, per annum	1200
Conductor	900
Total	$6334
Interest at 7 per cent	444
Wear and tear on dummy per annum, 10 per cent. on $4000	400
Expense of dummy	$7178
Expense of horse-car	8150
Difference about	$1000

From the foregoing it will be seen that by the application of steam to city railroad travel a saving of $1000 per car can be made.

In New-York City and the adjoining city of Brooklyn there are about two thousand four hundred street-cars in use.

ANOTHER ALPINE TUNNEL.

A CONTRACT has been signed between the directors of the St. Gothard Railway, Switzerland, and M. L. Favre, of Geneva, for the boring of a new railway tunnel through the Alps, which promises to surpass any thing of the kind yet attempted. The length of the tunnel will be a little more than nine miles; cost, $10,000,000. The work is to be finished in eight years; and if sooner finished, the contractor is to receive $1000 a day for each day in advance of the contract time. If the completion of the work is from any cause delayed beyond the contract time, $1000 a day are to be forfeited. If the delay reaches beyond six months, the forfeit is then to be increased to $2000 a day. The contractor deposits $1,000,000 as security for the faithful performance of the work. If the delay exceeds the contract time beyond one year, the contract is to be broken, and the company take possession of the security money. The contractor is an eminent civil engineer, and a man of rare abilities. He was formerly a journeyman carpenter in Paris. The work has been commenced. The American Burleigh Rock-Drills, operated by compressed air, are to be used.

A TRANSANDINE RAILWAY.

A TRANSANDINE survey, made jointly by the Argentine and the Chilian Governments, leaves little doubt of the possibility of railway communication between the Atlantic and Pacific. The length of such a communication would be about 1200 miles, of which nearly 400 miles are actually made.

THE AMERICAN PNEUMATIC RAILWAY BRAKE IN ENGLAND.

IT is without hesitation that we state our conviction that, by the adoption of such a brake as that recently introduced into this country by Mr. Westinghouse, collisions might cease to have any important existence. It is right that we should explain why we single out the Westinghouse from many other systems of continuous brakes, more or less efficient, which have been tested in this country. The reason is this: No locomotive superintendent or manager is justified in incurring a large expenditure on an unheard-of or comparatively untried invention. We know nothing of the existence of any other form of continuous brake which has been so extensively used as that we have named. In their immediate effect, all continuous brakes are pretty much the same, when once the wheels are skidded. The difference lies in the

means by which the wheels are skidded. We believe, in common with a very large body of engineers, that Mr. Westinghouse has solved the problem of constructing a good continuous brake. It is quite possible that a far better brake may be invented, but with this we have nothing to do. The Westinghouse brake has passed far beyond the limits of the first stage. Its construction occupies hundreds of hands and all the resources of a manufacturing establishment of great dimensions in the United States. All the principal American lines use it already, or are adopting it. Many hundreds of the little air-pumping engines have been made. The operation of the brake is eminently satisfactory. Why should it not be adopted extensively in this country? We are not hard to please; we do not, be it understood, write to advocate the adoption of the Westinghouse brake, but we write to advocate, nay, to insist on, the general adoption of a first-class continuous brake on our railways, no matter who is the inventor, and we cite the Westinghouse brake because it affords a direct and complete answer to those who argue that there is no good continuous brake in existence, and that they will wait till one is invented and tested. We cut the ground from beneath these gentlemen at once, by asserting that all that can be required is provided ready to their hand. It remains to be seen whether, among the multitude of our readers, one can be found to argue that we have advanced a single statement which is contrary to truth, reason, and common sense.—*London Engineer.*

THE COST OF TUNNELING.

THE Mont Cénis tunnel cost $975 per linear yard. The three most costly tunnels made in England have been the Kilsby, the Saltwood, and the Bletchingley, each of which was executed in treacherous strata, giving out large quantities of water. The Kilsby Tunnel cost $725 per yard. The Saltwood Tunnel cost $590 per yard, the Bletchingley, $360. The cost of the railway tunnels in France has varied from $150 per yard, being that of Terre Noire, on the Paris, Lyons, and Mediterranean Railway, to $475 per yard, that of Batignolles, near Paris, on the Chemin de Fer de l'Ouest. In Belgium, Braine le Compte Tunnel cost $230 per metre, and the tunnels on the Liege and Verviers line $250 per metre. In Switzerland the very difficult Hauenstein tunnel, between Basle and Berne, cost $400 a yard. In America, the Hoosac tunnel, in Massachusetts, through mica slate mixed with quartz, has up to this time cost $900 per yard, and the Moorhouse tunnel, in New-Zealand, through lava-streams and beds of tufa, in-

tersected by vertical dykes of phonolite, cost $345 per yard. It will be a convenient standard of comparison for these amounts if we remember that $125 per yard would represent very nearly $5,000,000 for the 22 miles. Any estimate for the Channel Tunnel must at present be purely conjectural, and an estimate professing to embrace contingencies must be more conjectural than any other, but it is reckoned that the work, if practicable at all, could be completed within five years of time and for $25,000,000.

PAPER CAR-WHEELS.

THE American Paper Car-Wheel Company, at Pittsford, Vt., manufacture R. M. Allen's patent paper car-wheels, which are coming into use quite largely. They are now in use on some of the Pullman palace-cars, and are said to give perfect satisfaction. They are more expensive than the common wheel, but it is claimed that they will wear longer, injure the track less, and run with less noise and jar than any other kind. They are manufactured by bringing a pressure of 350 tuns upon sheets of common straw paper, which forces them into a compact mass, which is then turned perfectly round; and the hub is forced into a hole in the centre, this requiring a pressure of 25 tuns. The tire is of steel, and has a one-quarter inch bevel upon its inner edge, thus allowing the paper filling to be forced in, 250 tuns' pressure being required in the process. Two iron plates, one upon each side of the paper, are bolted together, which prevents the possibility of the fillings coming out. The tire rests upon the paper only, and partakes of its elasticity.

RAILROAD RAILS AND TIRES.

A NEW style of rail proposed by J. A. Woodbury is made with a body of iron and a face of steel united during the process of manufacture in the ordinary manner, and then hardened by being heated, and passed, face downward, over a perforated pipe from which issue fine streams of water. By this means a rail is produced having an iron body and a steel face, the surface of which is extremely hard.

The same gentleman also suggests that tires may be manufactured by the use of a compound bar of iron and steel united at the ends to form a tire, and then hardened by heating and cooling by the use of a circular perforated pipe spraying water on the tread of the tire.

TO MELT SNOW on railroad tracks, street pavements, etc., R. B. Miller suggests that a tube be laid beneath, through which hot air or steam may be forced by suitable appliances.

STREET-RAILWAY.—The Third Avenue street-railway in New-York City carried twenty-eight millions of passengers last year, operated two hundred and eighty-three cars, and employed two thousand three hundred and forty-nine horses. The average expense of a two-horse street-car, and the maintenance of its horses, driver, conductor, interest, repairs, wear and tear, is estimated at $5000 per annum.

HARDENING STEEL RAILS.—J. L. Booth claims that if the ends of Bessemer or steel-capped rails be hardened, the durability of the rails will be considerably increased without adding much to the cost.

CAR-WHEELS.—A new style of car-wheel suggested by John Jay Young has a centre of cast-iron and a tire of cast-steel, having between them a band of wrought-iron, which is so arranged in the mould as to allow of the running in of both the cast-iron and cast-steel at the same time. The same gentleman also proposes to manufacture a tire having a wearing surface of steel and its inside face of wrought-iron or other soft and tough metal welded to the steel.

RAILROAD BATHING-CAR.—One of the latest suggested conveniences for railroad traveling is the proposal of Louis Bagger to furnish a car with bathing appliances. The car is to be divided in two parts for the different sexes, and to have hot and cold water, materials for furnishing salt-water and medicated baths, etc.

PROPELLING STREET-CARS.—To accommodate those who fear that their horses would be scared by the appearance of locomotives in the street, Abel Thompson proposes to build beneath the track a tunnel in which the locomotive shall travel and draw the cars on the track above-ground by means of a link passing through a narrow opening running the whole length of the top of the tunnel.

ELASTIC WHEELS.—A new style of wheel intended to be used on traction engines and for other purposes, described by G. M. Ramsay, consists in a rigid centre having an elastic tire, the two being connected by oval springs which are bolted to the rigid centre and the tire. As the tire is elastic, it will have a large amount of bearing surface like the rubber tires, but will not wear so fast; and vehicles furnished with it will not require springs.

LOCOMOTIVES.—Instead of applying sand to the rails to prevent slipping, Nathaniel Sehner proposes to apply chalk direct to the driving-wheels of locomotives, which he claims will prevent the wear of wheels and rails caused by the grinding action of the sand.

LOCOMOTIVE TRACK-BRUSH.—To prevent the wear of wheels and rails caused by the sand thrown under the wheels of locomotives to cause adhesion, Alexander Blakely proposes to provide each locomotive with rotary brushes, which shall act on the rails and sweep off such sand as may be left on after the driving-wheels have passed, and thus prevent the wear of succeeding wheels. These brushes are so arranged that they may be thrown in or out of gear at the option of the engineer.

NEW INTERNATIONAL BRIDGE.

THE project of bridging the Niagara River near Buffalo has been for years past a matter of interest to both American and Canadian engineers. Forming a part of the charter of the Buffalo and Lake Huron Railway, (now incorporated with the Grand Trunk Railway of Canada,) since the year 1858, successive parties of engineers, under different auspices, and at several points, have sounded the river with a view to the construction of a bridge. Failures of these various enterprises have prevented the accomplishment of the object until it was taken in hand by the Grand Trunk Railway, some four years ago. A company was formed of English and American capitalists, styled the International Bridge Company, with C. J. Brydges, Esq., of Montreal, as president. Active steps toward securing the necessary charters from the United States and Canadian governments were at once taken, the location of the bridge fixed and right of way secured, and in May, 1870, the works were begun under C. S. Gzowski & Co., the contractors.

It was decided that the bridge should be an iron superstructure on stone piers, and after much deliberation the Pratt truss, as manufactured at the Phœnixville Iron Works, Phœnixville, Pa., was adopted. This truss has been used in many bridges over the Ohio and Missouri rivers, and notably at the Quincy Bridge, over the Mississippi, where it has served most successfully. This was taken as the model upon which the International Bridge was to be constructed.

In an article on bridge-building, on another page, illustrations of the Phœnixville bridges will be found.

The spans of the International Bridge are as follows:

In Main River	4	spans	197 feet	=	788 feet.
" "	3	"	248 "	=	744 "
" "	1	draw	362 "	=	362 "
In Black Rock Harbor	1	span	223 "	=	223 "
" " "	1	draw	222 "	=	222 "
					2339 feet.

The piers are built in 12 x 12 inch timber caissons, made

water-tight, and strongly braced. The bottom, to a certain level, is filled with concrete, made of broken stone, fine gravel or sand, and Akron hydraulic cement. On this the footing course of heavy blocks of limestone is placed, and the pier built. The dimensions of the first three piers are as follows: Length of coping, 29 feet; width, 7 feet 6 inches; batter of back, 1 in 24; batter of front above cap of ice-breaker, 1 in 24; batter of ice-breaker, ½ to 1; angle of ice-breaker, 45 degrees; batter of sides, 1 in 24. The height of course varies with the depth of water.

The shape of the pier is an oblong, with a rectangular nose-piece, or cutwater.

Although delayed by a series of adverse circumstances, and the fact that no previous work of the kind afforded a precedent for dealing with so rapid a current as that of the Niagara, the contractors are pushing the work with the greatest energy, and hope to finish it early next year. Considering the difficulties they have had to contend with, and the fact that the speed of the current has been known to double inside of eight hours, the work presents difficulties such as an engineer seldom has to face. Much has been done, but much still remains to be done, before the iron horse can complete the international link between the two countries, and we trust that continued success may attend their efforts. (76)

WOODEN RAILWAYS.

THE wooden railroads built in the vicinity of Quebec have deservedly attracted much attention. The following data regarding them are given by Mr. Hulburt, the projector and contractor of several of these roads: There are now over a hundred miles in operation. The gauge is 4 ft. 8½ in. The running-time is about 16 miles per hour, but trains have been run at the rate of 35 miles per hour. The rails are made of maple, 4 x 7 inches, set up edgewise, and notched into the cross-ties 4 inches deep, and held by two wedges down in the notch on the outside of the rail. The ties are 8 inches thick, and laid 20 inches apart.

The cars have four wheels, and some of the engines weigh thirty tons. In frosty weather the driving-wheels have less adhesion than on metal rails, but no considerable difficulty is experienced from this cause. The rails will last from two to four years, according to the quality of the timber and the amount of the traffic.

The cost of such roads is from four to seven thousand dollars per mile. They seem to be very well adapted for light traffic, and, as soon as the business of such lines may require it, metal rails may be substituted for wood without any change in the equipment.

PRACTICAL FORMS OF GEARING.

WHY a bearing with end chase will keep smooth is plain, and why a smooth one is less liable to cut than one full of circumferential streaks, will be understood at once by those who comprehend the principle upon which the V tongue and groove frictional gearing, Fig. 1, is constructed, which is, in fact, a series of large streaks made to accomplish the very thing not wanted in a bearing. This is another case of new mechanical construction parallel with those of long bearings, equal length sliding surfaces, resting machines on three points, and the screwing on of wheels, which, though unquestionably correct in theory, and fully demonstrated by use to be right, has to be promulgated one generation at least in advance of the age in which they are put in practice, or their merits acknowledged.

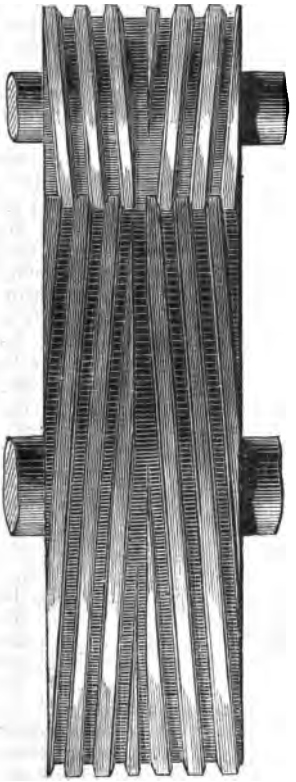


Fig. 1.—TONGUE AND GROOVE FRICTIONAL GEARING.

Figs. 1, 2, and 3 illustrate new forms of gearings, which go to show that, even in a field raked, it would seem, twenty times over, there may yet be found gems, or stones at least, and of merit depending in a measure on the application.

Of the crescent tooth, Fig. 2, there is said to be something like one hundred trains of rolls running with them and giving a fair degree of satisfaction. So far as smooth running goes, it possesses all the merits of the double spiral gear, with this advantage over that and all other gear, that one tooth works into the other like a ball-and-socket joint, and will, if allowed end-play, adjust itself so as to take a bearing the whole length, whether the two shafts be absolutely in line or not. One of the difficulties, thus far, is that of getting any thing like a perfect casting, or even a perfect pattern

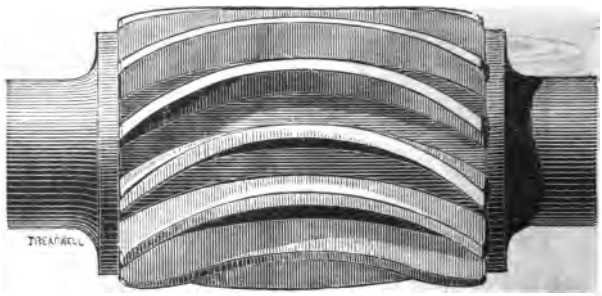


Fig. 2.—CRESCENT-SHAPE GEARING.

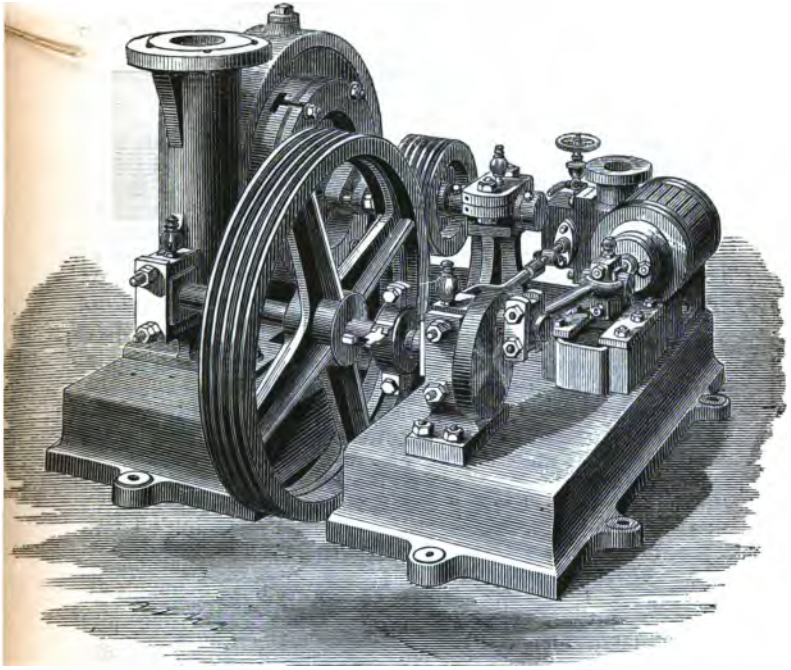
for that matter, and another is that such coarse pitch has been used and the pinions made so short, that the angle of the wearing surfaces of the ends of the pinions are so great, the grinding action frequently causes them to cut, which no lubrication will prevent. The first of these difficulties may possibly be overcome by the use of Scott's moulding machines, and the latter by making the pinions of finer pitch and of a length equal to at least one and a half diameters instead of only one diameter as here used.

Fig. 3.
SPHERICAL GEAR.

The spherical gear, Fig. 3, is designed to transmit motion in any direction, from a straight line where the teeth act as a clutch, through any angle up to 180°, or in the opposite direction, where the pinions operate like common spur-gearing, as they appear in the drawing. (28)

ROTARY FILE.—A convenient tool in a machine-shop, suggested by C. M. Nes, consists of a band of steel, file-cut on its outer face and both edges, mounted on a circular disk and run in a lathe or as a milling tool. It is to be attached to the disk by "shrinking on," which is done at the time it is hardened and tempered.

MELTING IRON SHAVINGS.—In re-working shavings, turnings, etc., they are usually inclosed in cast-iron boxes and the whole melted together in the furnace. As a substitute for the cast-iron, George Whitney proposes to inclose the scrap in pine boxes which will become charcoal in the furnace and supply the melted metal with carbon.



FRICTION-GEARED CENTRIFUGAL PUMP.

OUR sketch shows a centrifugal pumping-engine, constructed by Messrs. Marquis Brothers, of Glasgow. The engine and pump are fixed on the same bed-plate, and are connected by frictional gearing, the fly-wheel of the former being grooved around its periphery and gearing into a correspondingly grooved pinion on the pump-spindle. The arrangement is very compact, and provision is made for obtaining ready access to the pump-disk by removing a side door with which the casing is fitted. The piston-rod, connecting-rod, and pump-spindle are of steel, and large bearing surfaces are provided. The particular pump shown is intended for use on shipboard for pumping out water, ballast, etc., or for circulating the water in surface condensers. In some cases, Messrs. Marquis Brothers substitute ordinary for frictional gearing, while in others, as, for instance, when the lift is low, they connect the engine direct to the pump-spindle. (28)

A HUGE CASTING.

THE largest of the massive iron plates intended to form the foundation of the immense steam hammer to be erected in the Royal Gun Factories, Woolwich, Eng., was cast successfully in November, 1872. The casting, an open one, consumed about 100 tons of metal. The molten metal was collected in three enormous cupolas, and, at a given signal, the whole was simultaneously poured into a mould, which had been prepared previously for its reception. The heat from the molten metal, which covered an area of 24 feet, was so powerful as to break the glass in the open windows of the workshops. It was worthy of note that the large anvil-block for the same hammer, cast some three months previous, was not yet cool enough for removal.

NEW FUSIBLE BOILER-PLUG.

AT a meeting of the Society of Arts of the Massachusetts Institute of Technology, a new boiler-plug was exhibited by Mr. H. P. Longley, which seems to obviate many of the difficulties met with in the use of the ordinary safety fusible plugs. The ordinary fusible plug has usually been found objectionable from the fact that, after it has been in use for some time, it will not melt at as low a temperature as when first put in. There are many cases on record of the exploding of boilers provided with fusible plugs, and of the crown-plates of the same being overheated and distorted. To account for this, some have supposed that there was an actual elevation of the melting-point of the metal, but the more probable cause is the oxidation of the metal, a crust of oxide being formed on the flat surface of the plug of sufficient thickness to prevent, to a considerable extent, the action of the steam upon the plug. The old plugs were usually placed in the crown-sheet of the boiler, where they were exposed to the direct action of the steam or water on one side, and the intense heat of the fire on the other.

The fusible plug exhibited by Mr. Longley is placed outside the boiler at a level a little below the lower gage-cock, or it may take the place of this cock; it is so arranged that when the plug melts, the water and steam will be admitted directly into the fire-box, and extinguish the fire. The pipe in which the plug is placed is provided with a stop-cock, so that the boiler may be used after the melting of the plug, and thus much delay be avoided.

Mr. McMurtie spoke of the advantage of having a reliable safety-plug, and of the general disbelief in the usefulness of the plugs heretofore used.

An unrepealed law of the State of Massachusetts requires that every steam boiler in the State shall be provided with a fusible plug, but so nearly universal is the belief in their uselessness that it would be difficult to find a boiler with a plug properly inserted, or, indeed, with any plug at all.

Past experience teaches that there is no device which will fully take the place of care and watchfulness on the part of the engineer, and that where these are wanting, boilers will explode with or without fusible plugs. Several of the new plugs were blown out of a small boiler, in the metallurgical laboratory, after the meeting.

GEAR-WHEELS.

INSTEAD of cutting or casting teeth in gearing, John Comly proposes to mount red-hot blanks on a mandrel over a revolving die of such shape as to form the teeth by pressure in a manner somewhat similar to the method of making milled-heads on screws, etc. The die is set over a tank containing water, in which it revolves, to prevent its being injured by the red-hot blank. It is claimed that by this process a very strong tooth can be made, as the metal is compressed instead of being cut away.

RIFLING FIRE-ARMS.

A NEW system of rifling proposed by C. F. Winchester, consists in first boring and rifling the barrel in the usual manner, preferably with a gaining twist, then boring out the breech end about one third of its length, so as to remove the bands, leaving it a perfect smooth-bore at that section, and tapering from forty-five hundredths at the breech to forty-four hundredths at the fore part of this section. From this point the centre third of the barrel is tapered until the last third is reached, where it will be left at the full rifled bore of forty-two hundredths. By this method one third of the gun is smooth-bore to admit of the easy starting of the ball, a second third gradually tapering to make the ball fit the rifling, and the last third to impart the rotary motion.

LOOSE PULLEYS.—It has been suggested by C. F. Thayer that it would be an improvement on the present style of running loose pulleys to provide one of the hangers with a sleeve encircling the shaft on which the loose pulley should run, instead of running on the shaft itself—thereby saving the wear of the latter and preventing the damage sometimes caused by the accidental starting of machinery by the friction of the loose pulley on its bearing.

COATING WATER-PIPES IN MINES.

THE coal seams of many Silesian mines contain a considerable amount of pyrites, which mineral causes, through its gradual oxidation, the water in those mines to become acidulated, for it generally contains a perceptible amount of free sulphuric acid. This acid is highly injurious to the pumps, and will destroy them within less than ten years. For this reason, the pump cylinders are now almost exclusively made in those districts of gun-metal instead of cast iron, and the water-pipes which carry the pit water to the surface are protected against its corroding action by an inside coating of a kind of enamel, so that they now last twice as long as before. At the mine Königsgrube, the pipes to be coated are first exposed for three hours in a bath of diluted sulphuric or hydrochloric acid, and afterward brushed with water; they then receive an under coating composed of 34 parts of silica, 15 borax and 2 of soda, and are exposed for 10 minutes in a retort to a dull red-heat. After that, the upper coating is laid over the interior surface and the pipes are exposed to a white heat for 20 minutes in a retort, when the enamel perfectly unites with the cast iron. Before the pipes are quite cooled down, their outside is painted with coal tar. The upper coating consists of a mixture of 34 parts of felspar, 19 silica, 24 borax, 16 oxide of tin, 4 fluorspar, 9 soda, and 3 saltpetre; this is melted to a mass in a crucible, and afterward with little water ground to a fine paste. This mode of protecting pipes has proved a great success. (28)

PETROLEUM FURNACE.

M. WIESNEGG the well-knowen constructor of gas-heating apparatus, has just established in the laboratories of the Normal School and the school of the Sorbonne a furnace in which petroleum is employed. In M. Méne's *Revue de Chimie*, we find the description of this apparatus. A large cistern of wrought-iron serves to contain the combustible oil. The cistern is connected by rubber tubes to the apparatus for distributing the oil, and mounted on the furnace. This apparatus is composed of a pipe from which several tubes branch out and are fitted with cocks, and of a grooved grate along which the oil flows as it drops from the small tubes before mentioned. In the grate is placed a door which admits more or less air. The grate is vertical, and with four bars; the air passing between each bar burns by its oxygen the petroleum, vaporized by the heat of the fire which is maintained. At the bottom of the grate is placed a receiver where the oil, which drops, and which is not burnt at first, collects, and is volatilized gra-

dually by the heat of the fire, and burns afterward. To light this furnace, fire is put to straw or to paper, which burns fiercely when soaked with the oil, and gradually heats the furnace sufficiently to volatilize the dropping liquid, so that at the end of a short time it is the gas or the vapor which burns. The flame is long and very intense. Iron, copper, etc., can be heated by it, and temperatures are reached difficult to obtain by coal alone. The furnace requires no blast, and is specially adapted for the laboratory.

BEARINGS FOR JOURNALS.

G. R. MENEELY proposes to manufacture bearings of wrought-iron sheathed on the rubbing surface with bronze or similar alloy. The iron is first rolled out into bars having a cross-section like the bearings to be made, and then is cut off into suitable lengths, and coated in any convenient manner with the alloy. By the use of the wrought-iron backing a much harder alloy may be used without fear of breaking from concussion, and the first cost is much reduced.

ALLOYS FOR BEARINGS.

A GOOD alloy for bearings, where much concussion may be expected—as in railroad cars—can be made, according to a statement of C. J. A. Dick, by mixing eighty-two parts of copper, ten of tin, one of phosphorus, and seven of lead. Where friction alone is to be considered, a portion of the copper and tin may be omitted.

WELDING IRON TO STEEL.—It has been suggested that iron may be welded to steel—as in uniting the iron base of a railroad rail to a Bessemer steel cap—by making up a pile of iron and steel with a bar of iron made from Codorus ore, between the two, and thus, by properly heating and rolling, produce a rail having a Bessemer steel cap firmly united to an iron base.

SCREW-NUTS.—C. H. Guard proposes to make threaded nuts by winding wire around a threaded mandrel, following the thread thereof, until a spiral is formed as long as the nut is to be thick. The ends of the wire are then bent back and united by twisting, and a nut of brass or iron cast around it, thus forming a cast-metal nut with a wrought-metal thread.

CHECK-VALVE.—To enable the engineer to see when the check-valve is working, and thus know that his feed-pump is doing its duty, J. G. Blackburn proposes to cut away both sides of the tube over the stem and protect the openings by a glass tube, through which the movements of the valve can be readily seen and any irregularity of its motion detected.

COMBINED CANNON AND GATLING GUN.

ONE of the objections to the Gatling gun made by the military authorities is that it can not be made useful at long range. To obviate this, S. W. Wood suggests that a cannon and a Gatling gun be mounted on the same carriage, so arranged that the former may be used for long distances and the latter for short. With this combination the inventor thinks a battery may be formed which it would be very difficult, if not impossible, to take.

TORPEDOES.

A VERY interesting paper has been read by Mr. C. W. Merrifield, F. R. S., before the Institute of Naval Architects, on torpedo warfare, the main consideration being as to how a vessel may best be constructed with a view to defending it from the action of torpedoes; the one great principal advocated by Mr. Merrifield being that of subdivision. Extending armor-plates over the bottom of a vessel, while it would add considerably to its displacement, would not afford any sure means of defense; for appoaching a coast known to be protected by torpedoes, a number of small iron-clads were preferable to one large one, as in the event of a serious accident the loss in life as well as in material would be less. Again, these vessels should be absolutely subdivided into compartments, with air-tight coverings, so that in the event of an accident to one compartment, the water might be driven out by means of pumping air into it. In order to neutralize the effect of the blow given by the explosion of the torpedo, the author proposes that the bottoms of vessels should be constructed with double cells, the lower ones being filled with water, which, acting as a buffer, would distribute the blow of concussion and render it less injurious to the fabric of the vessel; the upper cells should be connected by means of pipes and stop-cocks with an air-pump, so that in the event of the middle skin becoming broken the upper cell would be cleared of water by means of a plenum.

NEW TORPEDO

A NEW apparatus has lately been tested before a board of army and navy officers at Newport, R. I. From the report of the performances we are led to believe that the inventor, Mr. John L. Lay, has accomplished an important step in advance of the science of submarine naval warfare. The hull of the craft is about thirty feet long and three inches wide, cigar-shaped, and formed, water and air tight, of iron plates. It is divided into three compartments; one for motive power, another for machinery and the third

for electrical apparatus. The motive power consists in carbonic acid gas compressed in sufficient quantity to drive a pair of oscillating engines of eight horse-power, and thus operate the screw for the period of half an hour, during which time the boat is designed to travel some six or eight miles. The machinery is controlled by wires leading to a battery on shore, the opening or closing of the circuit or wire governing the throttle, and the same on the second wire actuating the steering-gear. The cable containing the wire is paid out as the boat moves, as, of course, no crew is required on board. The vessel is almost entirely submerged, and being painted green, is indistinguishable at short distances by the unaided eye.

In the magazine are placed 500 lbs. of powder or nitroglycerin, and in the forward portion of the vessel explosive shells are also arranged, to be fired by an electric spark passing through a third wire in the cable. The explosion of the shells may be effected without injury to the boat, but that of the magazine necessarily causes her destruction. During the experiment at Newport, a torpedo charged with ten pounds of powder was put in position, and then the boat was started for the shore of Goat Island. It darted off like a harpooned whale, and described a complete circuit of the harbor, going a distance of about two miles. The operator, who remained on shore, had perfect control of the craft, and with his electrical switches moved her to port or starboard, and stopped her at will. Having demonstrated for a considerable time the facility with which she could be propelled and guided, her course was changed to the shore or point from which she started. Then she was again sent out in the direction of a large row-boat, which had been anchored as an imaginary vessel of an enemy a short distance from the island. The bow of the boat, the point where the torpedo was placed, was directed against the row-boat, and instantaneously there followed the explosion of the projectile. The water was thrown about thirty-five feet or more into the air, and the timbers of the boat were sent flying in all directions. Quite a large number of prominent foreign officers witnessed the tests, and pronounced favorable opinions at their close.

TIDAL POWER.—To utilize the motion of the tide in driving machinery, J. B. Atwater proposes to mount a screw propeller, on a suitable frame, in some place where the ebb and flow of the tide would be most effective in driving it, and to use the power thus obtained to operate a pump to compress air into a reservoir, from which a tube may lead to an air-engine located at any place within a reasonable distance from the reservoir.

PNEUMATIC METHOD OF PREVENTING EXPLOSIONS IN COAL-MINES.

DIMINISHED atmospheric pressure is frequently followed by the escape of fire-damp into the workings of a colliery. To obviate the risk incurred by such barometrical changes, I propose, says Professor J. A. R. Newlands, in the *Chemical News*, that artificial means should be adopted, so as to maintain the atmospheric pressure within a given mine always at one and the same level, and also, if desired, to work under a somewhat increased atmospheric pressure. Taking the case of a mine having a downcast and an upcast shaft, the mouth of each of these should be covered over by an air-tight chamber, capable of withstanding a moderate pressure either from within or without This air-tight chamber might be conveniently constructed of sheet-iron, provided with thick glass windows; it should also be made sufficiently large to admit of all the usual operations at the pit's mouth being conducted within it. The shaft of the engine used for raising coal would pass through the sides of this air-tight chamber, so as to move the necessary hoisting apparatus within. Connected with this air-tight chamber an air-tight room should be constructed provided with two sliding doors, the inner door separating it from the air-tight chamber, and the outer door preventing contact with the external atmosphere. It will be seen at a glance that when the outer door of the room is shut, and the inner open, the room becomes part and parcel of the air-tight chamber, so that any truck laden with coal might be run from the air-tight chamber into the room, and then (by closing the inner door of the room and opening the outer) on to the ground surrounding the pit's mouth, without sensibly altering the pressure within the pit itself.

To produce the requisite current of air for ventilating the pit the air-tight chamber over the downcast shaft should be connected with powerful air-pumps, worked by steam, so that a continuous current of fresh air might be forced through all the workings of the pit before finally escaping through a pressure-valve from the air-tight chamber over the upcast shaft. Any required degree of ventilation, or of increased atmospheric pressure, could thus be produced within the pit. As no fire would be wanted in the upcast shaft it would be available for hoisting coal, etc. The air supplied to the mine might, if required, be easily cooled, by compressing it in cylinders surrounded with cold water before allowing it to pass into the pit, and thus the temperature of the pit might be reduced to any extent. The air issuing from the pit should

be chemically tested at stated hours, and whenever the fire-damp appeared to be increasing, the men and horses should be brought up, and the air-pumps should be employed in drawing air out of the mine, so as to diminish the pressure within, and thus cause any imprisoned marsh-gas to be brought out of its hiding-place. After keeping the mine under diminished pressure for some hours, a rapid current of air should be driven through the workings, and when—by testing the air passing through the escape-valve—it was found to be nearly pure, operations could be safely recommenced.

STEAM-JET FOR EXHAUSTING AIR—THE RESULTS OF ITS APPLICATION.

By C. W. Siemens.—The air to be propelled by the steam-jet is admitted through an exterior annular orifice surrounding the jet, and also through the centre of the hollow jet; and the area of the air-passages is gradually contracted on approaching the jet, whereby the velocity of motion of the entering air is so much accelerated, before it is brought in contact with the steam, as to avoid the great difference in the velocity of the two currents at the point where they come together, which cause the eddies that previously impaired the efficiency of the steam-jet. By the annular form of the steam-jet the extent of surface contact between the steam and air is greatly increased, and the quantity of air delivered is by this means very much augmented in proportion to the quantity of steam employed. The combined jet of steam and air is discharged through an expanding delivery-pipe of considerable length, in which its velocity is gradually reduced, and its momentum accordingly utilized by being converted into pressure. This improved steam-jet has been applied for exhausting one of the pneumatic dispatch-tubes employed at the Central Telegraph Station in London, for conveying the carriers containing telegraphic dispatches from one station to another. Another application is to the lifting of water from a moderate depth; for exhausting the vacuum-pans employed in sugar-boiling; and as a blower for accelerating the distillation of fuel in gas-producers for heating purposes.

THE BATTERY, NEW-YORK.

In connection with this favorite New-York resort, it may be noted that a new pier is being constructed. The new pier will be 500 feet long and 80 feet wide, and it will be supported on 19 arches. These are placed upon foundations of huge blocks of artificial stone.

DRAINAGE OF FERRARA MARSHES.

MOST continental travelers are acquainted with that vast expanse of water in Northern Italy known as the Ferrara Marshes, covering nearly two hundred square miles of what was once the most fertile land in Italy. An Anglo-Italian Company has been formed for the purpose of reclaiming these watery wastes, and plans for accomplishing the work were solicited from the most celebrated hydraulic engineers in this country and on the Continent, and the choice fell on Messrs. John and Henry Gwynne, of Hammersmith, England, to whom the contract for the whole of the machinery has been given. The body of water to be drawn off the land is over 2000 tons per minute, and as the consumption of fuel was a consideration of primary importance, these gentlemen have guaranteed that the maximum consumption of coal shall not exceed $1\frac{3}{4}$ lb. per indicated horse-power per hour, and to deliver the whole of the machinery in ten months. The engines will be on the compound surface condensing principle, of 1400 horse-power, working centrifugal pumps, and we believe are the first that have been constructed for drainage purposes on this principle.

ASPHALTUM AS FUEL.

ACCORDING to a statement made by Levi Stevens, asphaltum may be burnt as fuel, by an apparatus of his invention, without the usual trouble experienced in all plans hitherto tried. His improvement consists in a peculiarly-shaped double-walled burner combined with an open chamber containing the asphaltum. Steam is admitted in the space between the heated double walls, where it is super-heated, and then passing in a pipe through the asphaltum liquefies it, and as the latter runs from the chamber, it is atomized by the super-heated steam escaping from the end of the pipe above mentioned. The decomposed steam and asphaltum as they mingle are ignited and burnt—the combustion keeping up sufficient heat in the burner to decompose the steam, and furnishes a flame which may be used to heat steam boilers, etc., or it may be used to desulphurize and carbonize ore.

CEMENTS.—In that class of cements made from the argillo-magnesian limestone found along the Appalachian Mountains, some of the useful constituents are lost by the burning, and to supply these, D. O. Saylor mixes with the burnt material one fifth the quantity of raw stone, and the two are thoroughly mixed by crushing and grinding together.

SCREW PROPELLER.

AN improvement in the design and construction of the blades of screw propellers, for steam vessels, has lately been patented by Hermann Hirsch, London.

This is intended to remedy the great vibration produced by ordinary screw propellers, by obtaining the best effect in converting the force given out in a rotation into a pressure directed in the line of the axis, so as to produce a maximum amount of longitudinal pressure as useful effect for propulsion. To obtain such maximum of useful effect, the improved screw propeller, or each blade of the same, is so curved that the direction in which the water yields will be a direction converging from the periphery of the blade toward the axial line of the propeller; and consequently opposed to the centrifugal action which the rotary motion of the blades tends to impart to the water. Thus this curvature of the blade counteracts the centrifugal action, and so utilizes for propulsion the power that would otherwise be wasted.

The effect will be to drive the water in a cylindrical column aft in an axial direction relative to the screw, thereby producing the most direct and economical application of the power applied to the propeller, and at the same time avoiding vibration and increasing the efficiency of the rudder by surrounding it with a column of unbroken water, thrown directly against it with considerable velocity.

GRANITE WORKS OF THE ANCIENTS.

THE art of carving in granite has never been carried to higher perfection than on the continent of India. At Chillambaram, also in the Carnatic, and on the Coromandel coast, is a congeries of temples representing the sacred Mount of Meru. Here are seven lofty walls, one within the other, round the central quadrangle, and as many pyramidal gateways in the midst of each side, which form the limbs of a vast cross, consisting altogether of twenty-eight pyramids. There are consequently fourteen in a line, which extend more than a mile in one continuous direction! Nor are these the only wonders associated with this metropolis of pyramids. The interior ornaments are in harmony with the whole; from the nave of one of the principal structures there hang, on the tops of four buttresses, festoons of chains, in length about 548 ft. Each garland, consisting of twenty links, is made of *one piece of granite 60 ft. long;* the links themselves are monstrous rings, 32 in. in circumference, and polished as smooth as glass. Compared with the monolith temples of granite at Mahabalipuram, which is likewise situated on the Coro-

mandel coast, those in Egypt sink into insignificance. The rocks thereabouts are composed of a hard gray granite, containing quartz, mica, and felspar, with a few crystals of hornblende interspersed. Many have been hollowed out by art, and sculptured into temples with spirited bas-reliefs, representing episodes in Hindu history and mythology, and supported by graceful columns, all carved from the solid rock. Detached masses have been cut into shapes of elephants, tigers, lions, bulls, cats, monkeys, and various nondescript monsters, and colossal statues of gods; one of which, namely, that of Ganesa, being 30 ft. high. The southernmost of the temples is about 40 ft. in height, 27 ft. in breadth, and nearly the same in length; the exterior being covered with elaborate sculptures. The adjoining edifice is about 49 ft. in length, and in breadth 25 ft; it is rent by natural causes from summit to base. According to the local Brahminical tradition, these wonderful sculptures were executed by 4000 workmen, who had come from the north, and returned before their completion. From a careful examination, it is evident that almost all the enormous mass of sculpture and carving that adorns this city of monolith temples and colossi, must have been performed without the aid of fire—with the hammer, chisel, lever, and wedge alone; and this is one of the hardest rocks in the world! (82)

ALBOLITHE CEMENT.

A NEW cement, stated to possess excellent hardening qualities, is made by calcining magnesite (the carbonate of magnesia) in ovens similar to those used for gas-making, after which it is pulverized and mixed with a quantity of fine silica. The cement is declared to possess great hardness and durability. It may be moulded like plaster; it may be used to reface the dilapidated stones of a building, and adheres with so much tenacity to wood that its application as a preserver of timbers, railway sleepers, etc., by painting it upon the surface, has been tried with success.

DECAY OF STONE.

DR. R. ANGUS SMITH has observed that the particles of stone most liable to be in long contact with rain from town atmospheres, in England at least, were most subject to decay.

Believing the acid in the rain to be the cause, he supposed the endurance of a silicious stone might be measured by its resistance to acids. He proposed, therefore, to use stronger solutions, and thus to approach to the action of long periods of time. He tried a few specimens in this way, and with most promising results.

Pieces of stone of about one cubic inch in size were broken, by allowing a hammer to fall upon them, the number of blows required to produce fracture being counted. Similar pieces were steeped in diluted acid; both sulphuric and muriatic were tried, and the latter preferred. The number of blows now necessary was counted. Some sandstones gave way at once, and crumbled into powder; some resisted long. One very dense silicious stone was but little affected. It had stood on a bridge (in a country place, however,) unaltered for centuries.

These trials are merely the beginnings of a very extensive set of experiments about to be undertaken by Dr. Angus Smith, with a view to establish a standard of comparison.

PROFITABLE SEWAGE.

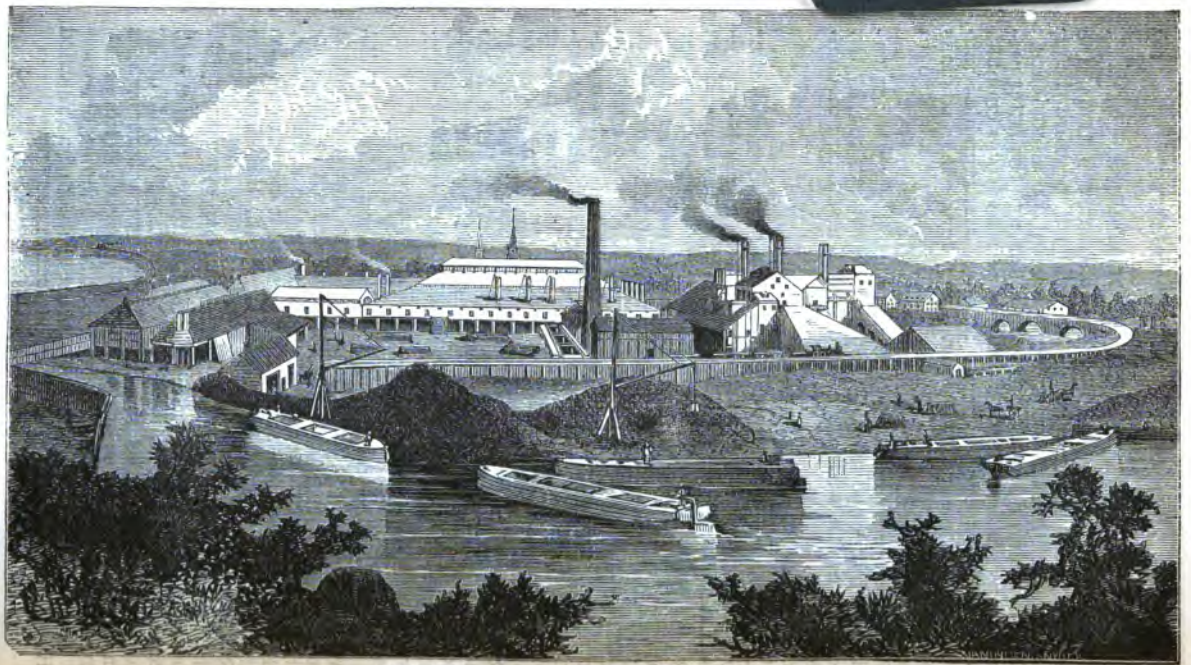
THE sewage of the town of Cheltenham, England, after passing through tanks, where the solid matter is precipitated, flows by gravitation over a farm of 127 acres, about three miles from the town, which has been purchased for the purpose by the town commissioners. This farm is divided into seven lots, and is yearly let by auction, it being a condition that the sewage liquid shall be applied in the discretion of the borough surveyor, under whose management the irrigation works are placed. With the exception of one lot of six acres, the farm is ordinary pasture ground, the excepted field being laid down with rye grass. The third annual letting was held on Thursday the 31st inst., the total result of the letting being $4000 for the year. The cost of the farm to the town of Cheltenham, with the necessary irrigation works, was about $90,000.

MELTING SNOW IN THE STREETS.

To clear the streets of cities from snow, Messrs. Folkmann and Kolgen propose to attach to the gas-mains a hose having on its end a nozzle provided with a large gas-burner, or a series of them, so as to make a wide flame, which is to be held near the snow until it melts, and to be moved about from place to place until the streets are cleared.

PREVENTIVE FOR OXIDATION OF IRON.

IT is stated by W. H. Sterling that, if iron be treated with paraffine heated to about 300° F. in a close vessel, under a pressure of from 150 to 200 lbs. per square inch, it will enter the pores of the iron and preserve it from rusting. The iron, when in its place in a building or otherwise, may be further treated with a coating of a saturated solution of resin, paraffine, or rubber in benzine.



THE PHŒNIX IRON AND BRIDGE WORKS, PHŒNIXVILLE, PA.

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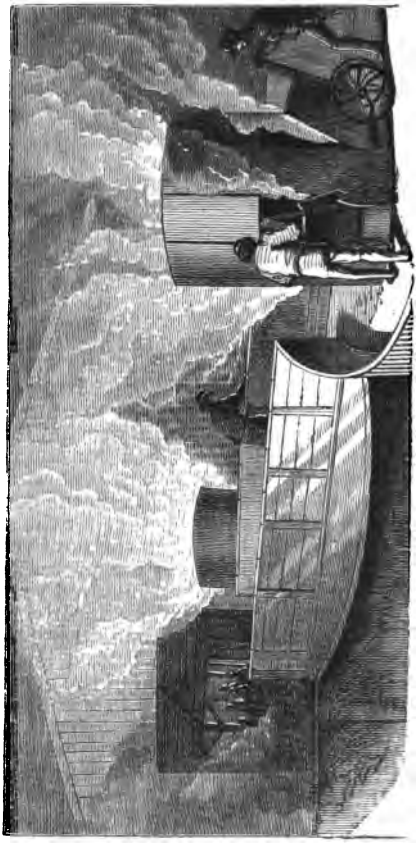
PHŒNIXVILLE BRIDGE-WORKS.

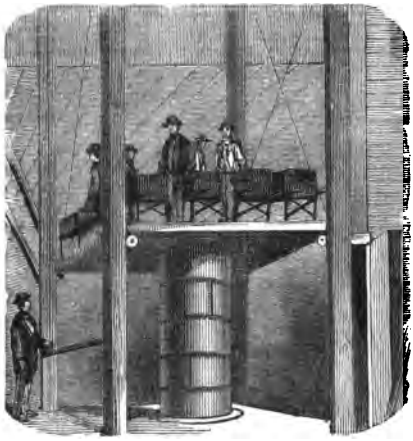
By Edward Howland.—The various processes by which the iron is prepared to be used in bridge-building are many of them as new as is the use of this material for this purpose, and it will not be amiss to spend a few moments in examining them before presenting to our readers illustrations of some of the most remarkable structures of this kind. Taking a train by the Reading Railroad from Philadelphia, we arrive in about an hour at Phœnixville, in the Schuylkill Valley, where the Phœnix Iron and Bridge Works are situated. In this establishment we can follow the iron from its original condition of ore to a finished bridge, and it is the only establishment in this country, and most probably in the world, where this can be seen.



DUMPING ORE AND COAL INTO BLAST-FURNACES.

These works were established in 1790. In 1827 they came into the possession of the late David Reeves, who by his energy and enterprise increased their capacity to meet the growing demands of the time, until they reached their present extent, employing constantly over fifteen hundred hands.

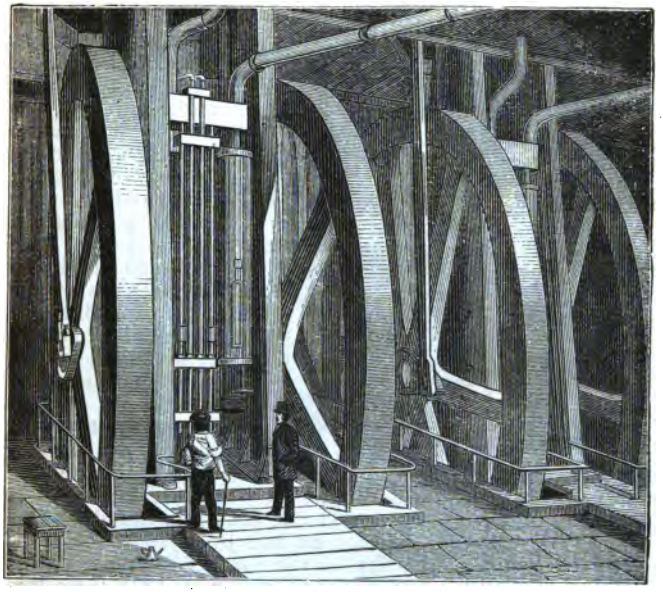
The first process is melting the ore in the blast-furnace. Here the ore, with coal and a flux of limestone, is piled in



THE ELEVATOR.

and subjected to the heat of the fires, driven by a hot blast and kept burning night and day. The iron, as it becomes melted, flows to the bottom of the furnace, and is drawn off below in a glowing stream. Into the top of the blast-furnaces the ore and coal are dumped, having been raised to the top by an elevator worked by a blast of air. It is curious to notice how slowly the experience was gathered from which has resulted the ability to work iron as it is done here. Though even at the first settlement of this country the forests of England had been so much thinned by their consumption in the form of charcoal in her iron industry as to make a demand for timber from this country a flourishing trade for the new settlers, yet it was not until 1612 that a patent was granted to Simon Sturtevant for smelting iron by the consumption of bituminous coal. Another patent for the same invention was granted to John Ravenson the next year, and in 1619 another to Lord Dudley; yet the process did not come into general use until nearly a hundred years later.

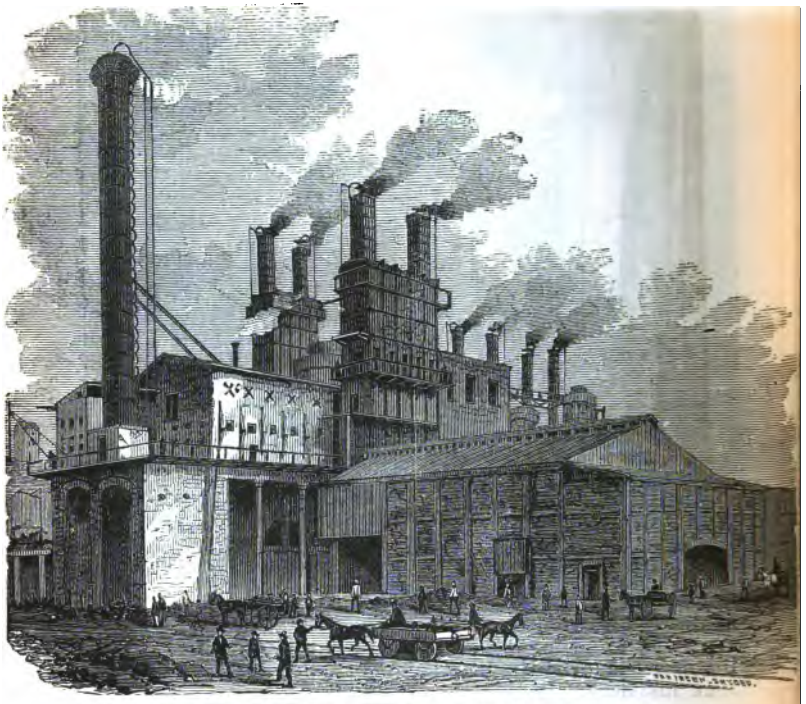
The blast for the furnace is driven by two enormous engines, each of three hundred horse-power. The blast used here is, as we have said, a hot one, the air being heated by the consumption of the gases evolved from the material itself. The gradual steps by which these successive modifications were introduced is an evidence of how slowly industrial processes have been perfected by the collective experience of generations, and shows us how much we of the present day owe to our predecessors. From the earliest times, as among the native smiths of Africa today, the blast of a bellows has been used, in working iron, to increase the heat of the combustion by a more plentiful supply of oxygen. The blast-furnace is supposed to have been first used in Belgium, and to have been introduced into England in 1558. Next came the use of bituminous



THREE HUNDRED HORSE-POWER ENGINES.

coal, urged with a blast of cold air. But it was not until 1829 that Neilson, an Englishman, conceived the idea of heating the air of the blast, and carried it out at the Muirkirk furnaces. In that year he obtained a patent for this process, and found that he could from the same quantity of fuel make three times as much iron. His patent made him very rich: in one single case of infringement he received a check for damages for one hundred and fifty thousand pounds. In his method, however, he used an extra fire for heating the air of his blast. In 1837 the idea of heating the air for the blast by the gases generated in the process was first practically introduced by M. Faber Dufour, at Wasseralfingen, in the kingdom of Würtemberg.

In this country, charcoal was at first used universally for smelting iron, anthracite coal being considered unfit for the purpose. In 1820 an unsuccessful attempt to use it was made at Mauch Chunk. In 1833, Frederick W. Geisenhainer, of Schuylkill, obtained a patent for the use of the hot blast with anthracite, and in 1835 produced the first iron made with this process. In 1841, C. E. Detmold adaptedt he consumption of the gases produced by the

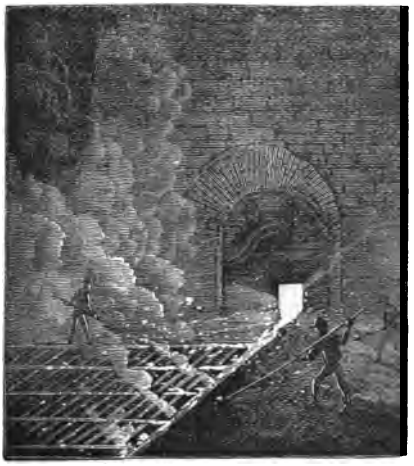


BLAST-FURNACES OF THE PHŒNIX BRIDGE-WORKS.

smelting to the use of anthracite; and since then it has become quite general, and has caused an almost incalculable saving to the community in the price of iron.

The view of the engines which pump the blast will give an idea of the immense power which the Phœnix Company has at command. Twice every day the furnace is tapped, and the stream of liquid iron flows out into moulds formed in the sand, making the iron into pigs—so called from a fancied resemblance to the form of these animals. This makes the first process, and in many smelting establishments this is all that is done, the iron in this form being sold and entering into the general consumption.

The next process is "boiling," which is a modification of "puddling," and is generally used in the best iron-works in this country. The process of puddling was invented by Henry Cort, an Englishman, and patented by him, in 1783



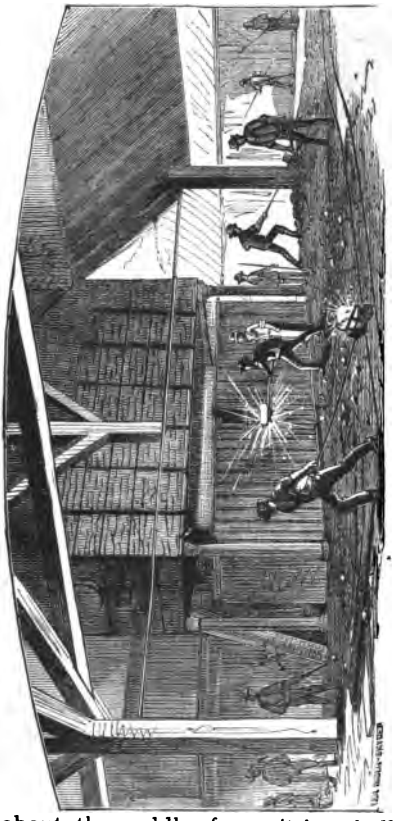
RUNNING THE METAL INTO PIGS.

and 1784, as a new process for "shingling, welding, and manufacturing iron and steel into bars, plates, and rods of purer quality and in larger quantity than heretofore, by a more effectual application of fire and machinery." For this invention Cort has been called "the father of the iron-trade of the British nation," and it is estimated that his invention has, during this century, given employment to six millions of persons, and increased the wealth of Great Britain by three thousand millions of dollars. In his experiments for perfecting his process Mr. Cort spent his fortune, and though it proved so valuable, he died poor, having been involved by the government in a lawsuit concerning his patent which beggared him. Six years before his death, the government, as an acknowledgment of their wrong, granted him a yearly pension of a thousand dollars, and at his death this miserly recompense was reduced to his widow to six hundred and twenty-five dollars.

When iron is simply melted and run into any mould, its texture is granular, and it is so brittle as to be quite unreliable for any use requiring much tensile strength. The process of puddling consisted in stirring the molten iron run out in a puddle, and had the effect

THE IRON BOILING FURNACE.

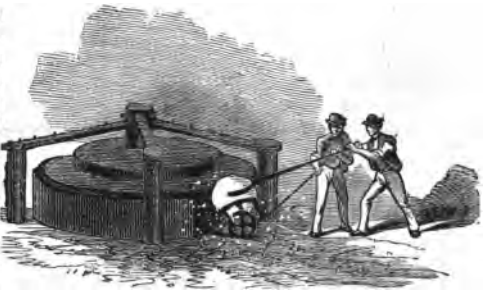
of so changing its atomic arrangement as to render the process of rolling it more efficacious. The process of boiling is considered an improvement upon this. The boiling-furnace is an oven heated to an intense heat by a fire urged with a blast. The cast-iron sides are double, and a constant circulation of water is kept passing through the chamber thus made, in order to preserve the structure from fusion by the heat. The inside is lined with fire-brick covered with metallic ore and slag over the bottom and sides, and then, the oven being charged with the pigs of iron, the heat is let on. The pigs melt, and the oven is filled with molten iron. The puddler constantly stirs this mass with a bar let through a hole in the door, until the iron boils up, or "ferments," as it is called. This fermentation is caused by the combustion of a portion of the carbon in the iron, and as soon as the excess of this is consumed, the cinders and slag sink to the bottom of the oven, leaving the semi-fluid mass on the top. Stirring this about, the puddler forms it into balls of such a size as he can conveniently handle, which are taken out and carried on little cars, made to receive them, to "the squeezer."



CARRYING THE IRON BALLS TO THE SQUEEZER.

To carry on this process properly requires great skill and judgment in the puddler. The heat necessarily generated by the operation is so great that very few persons have the physical endurance to stand it. So great is it that the

clothes upon the person frequently catch fire. Such a strain upon the physical powers naturally leads those subjected to it to indulge in excesses. The perspiration which flows



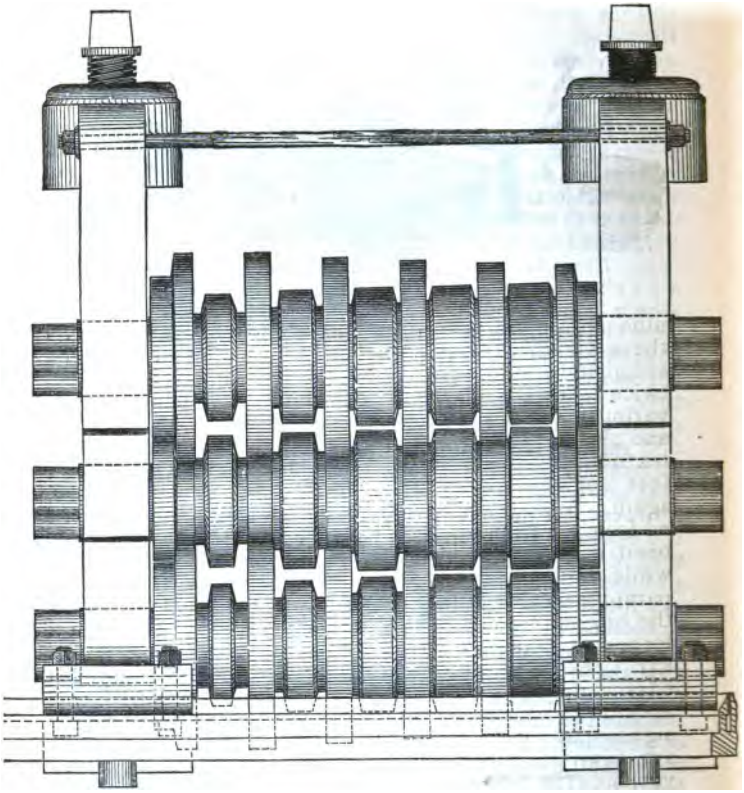
THE ROTARY SQUEEZER.

from the puddlers in streams while engaged in their work is caused by the natural effort of their bodies to preserve themselves from injury by keeping their normal temperature. Such a consumption of the fluids of the body causes great thirst, and the exhaustion of the labor, both bodily and mental, leads often to the excessive use of stimulants. In fact, the work is too laborious. Its conditions are such that no one should be subjected to them. The necessity, however, for judgment, experience, and skill on the part of the operator has up to this time prevented the introduction of machinery to take the place of human labor in this process. The successful substitution in modern times of machines for performing various operations which formerly seemed to require the intelligence and dexterity of a living being for their execution, justifies the expectation that the study now being given to the organization of industry will lead to the invention of machines which will obviate the necessity for human suffering in the process of puddling. Such a consummation would be an advantage to all parties concerned. The attempts which have been made in this direction have not as yet proved entirely successful.

In the squeezer the glowing ball of white-hot iron is placed, and forced with a rotary motion through a spiral passage, the diameter of which is constantly diminishing.

The effect of this operation is to squeeze all the slag and cinder out of the ball, and force the iron to assume the shape of a short thick cylinder, called "a bloom." This process was formerly performed by striking the ball of iron repeatedly with a tilt-hammer.

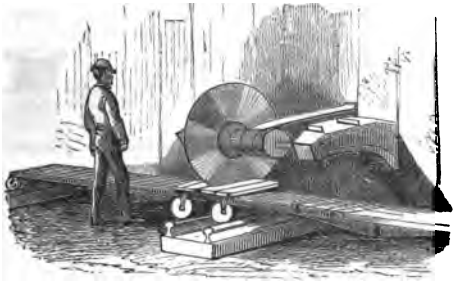
The bloom is now re-heated and subjected to the process of rolling. "The rolls" are heavy cylinders of cast-iron placed almost in contact and revolving rapidly by steam-power. The bloom is caught between these rollers,



THE ROLLS.

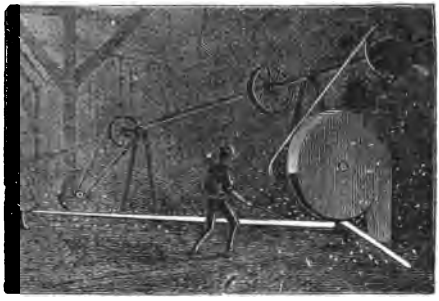
and passed backward and forward until it is pressed into a flat bar, averaging from four to six inches in width, and about an inch and a half thick. These bars are then cut into short lengths, piled, heated again in a furnace, and re-rolled. After going through this process they form the bar iron of commerce. From the iron reduced into this form the various parts used in the construction of iron bridges are made by being rolled into shape, the rolls through which the various parts pass having grooves of the form it is desired to give to the pieces.

These rolls, when they are driven by steam, obtain this generally from a boiler placed over the heating or



COLD SAW.

pudling-furnace, and heated by the waste gases from the furnace. This arrangement was first made by John Griffin, the superintendent of the Phœnix Iron Works, under whose direction the first rolled iron beams over nine inches thick that were ever made were produced at these works. The process of rolling toughens the iron, seeming to draw out its fibres; and iron that has been twice rolled is considered fit for ordinary uses. For the various parts of a bridge, however, where great toughness and tensile strength are necessary, as well as uniformity of texture, the iron is rolled a third time. The bars are therefore cut again into pieces, piled, re-heated, and rolled again. A bar of iron which has been rolled twice is formed from a pile of fourteen separate pieces of iron that have been rolled only once, or "muck bar," as it is called; while the thrice-rolled bar is made from a pile of eight separate pieces of double-rolled iron. If, therefore, one of the original pieces of iron has any flaw or defect, it will form only a hundred and twelfth part of the thrice-rolled bar. The uniformity of texture and the toughness of the bars which have been thrice rolled are so great that they may be twisted, cold, into a knot without showing any signs of fracture. The bars of iron, whether hot or cold, are sawn to the various required lengths by the hot or cold saws shown in the illustrations, which revolve with great rapidity.



HOT SAW.

For the columns intended to sustain the compressive thrust of heavy weights, a form is used in this establish-

RIVETING A COLUMN.

ment of their own design, and to which the name of the "Phœnix column" has been given. They are tubes made from four or from eight sections rolled in the usual way and riveted together at their flanges. When necessary, such columns are joined together by cast-iron joint-blocks, with circular tenons which fit into the hollows of each tube.

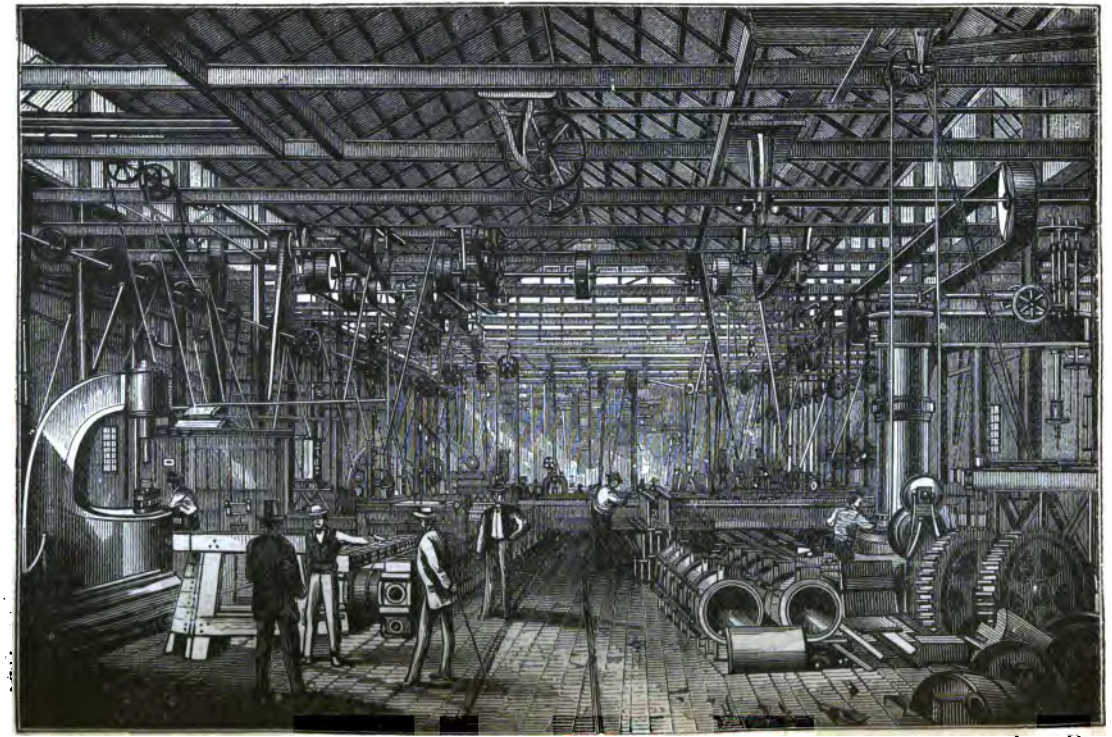
To join two bars to resist a strain of tension, links or eye-bars are used from three to six inches wide, and as long as may be needed. At each end is an enlargement with a hole to receive a pin. In this way any number of bars can be joined together, and the result of numerous experiments made at this establishment has shown that under sufficient strain they will part as often in the body of the bar as at the joint. The heads upon these bars are made by a process known as die-forging. The bar is heated to a white heat, and under a die worked by hydraulic pressure the head is shaped and the hole struck at one operation. This method of joining by pins is much more reliable than welding. The pins are made of cold-rolled shafting, and fit to a nicety.

The general view of the machine-shop, which covers more than an acre of ground, shows the various machines and tools by which iron is planed, turned, drilled, and handled as though it were one of the softest of materials. Such a machine-shop is one of the wonders of this century. Most of the operations performed there, and all of the tools with which they are done, are due entirely to modern invention, many of them within the last ten years. By means of this application of machines great accuracy of work is obtained, and each part of an iron bridge can be exactly duplicated if necessary. This method of construction is entirely American, the English still building their iron bridges mostly with hand-labor. In consequence also of this method of working, American iron bridges, despite the higher price of our iron, can successfully compete in Canada with bridges of English or Belgian construction. The American iron bridges are lighter than

those of other nations, but their absolute strength is as great, since the weight which is saved is all dead weight, and not necessary to the solidity of the structure. The same difference is displayed here that is seen in our carriages with their slender wheels, compared with the lumbering, heavy wagons of European construction.

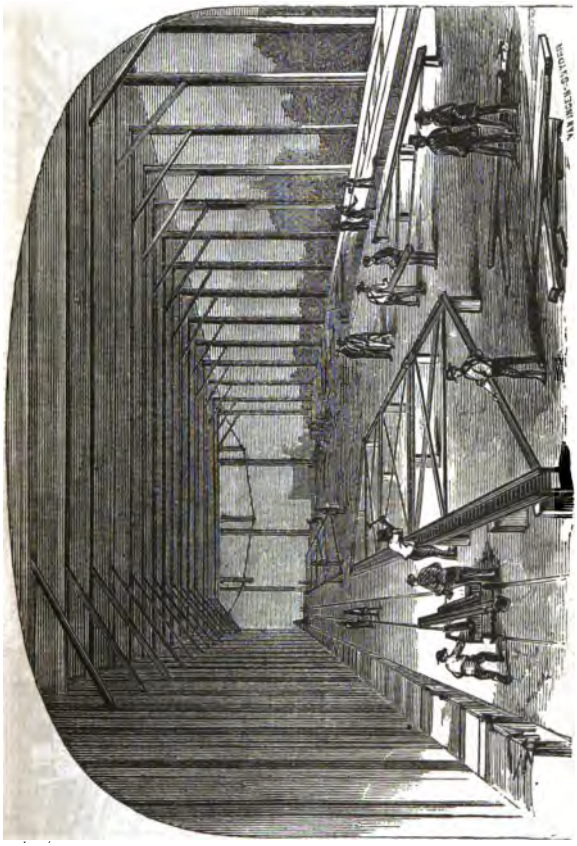
FURNACE AND HYDRAULIC DIE.

Before any practical work upon the construction of a bridge is begun the data and specifications are made, and a plan of the structure is drawn, whether it is for a railroad or for ordinary travel, whether for a double or single track, whether the train is to pass on top or below, and so on. The calculations and plans are then made for the use of such dimensions of iron that the strain upon any part of the structure shall not exceed a certain maximum, usually fixed at ten thousand pounds to the square inch. As the weight of the iron is known, and its tensile strength is estimated at sixty thousand pounds per square inch, this estimate, which is technically called "a factor of safety" of six, is a very safe one. In other words, the bridge is planned and so constructed that in supporting its own weight, together with any load of locomotives or cars which can be placed upon it, it shall not be subjected to a strain over one sixth of its estimated strength.



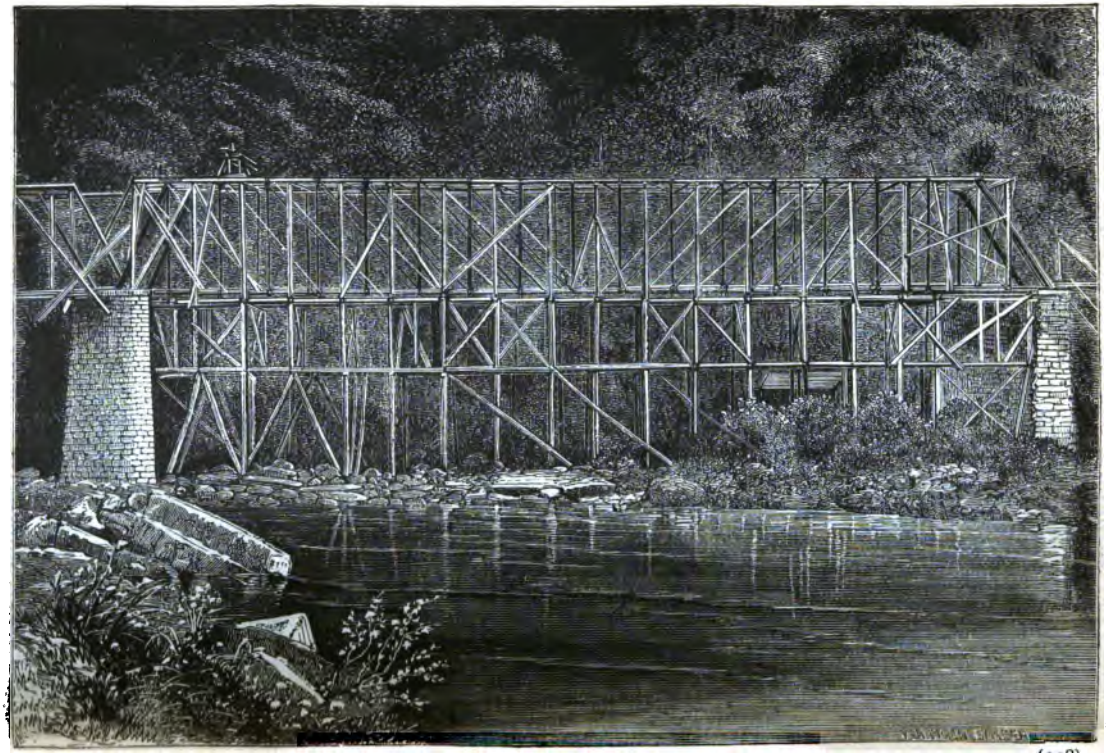
MACHINE-SHOP OF THE PHŒNIXVILLE BRIDGE-WORKS. (p. 206)

After the plan is made, working drawings are prepared and the process of manufacture commences. The eye-bars, when made, are tested in a testing-machine at double the strain which by any possibility they can be put to in the bridge itself. The elasticity of the iron is such that



THE "ASSEMBLING" SHED.

after being submitted to a tension of about thirty thousand pounds to the square inch it will return to its original dimensions; while it is so tough that the bars, as large as two inches in diameter, can be bent double, when cold, without showing any signs of fracture. Having stood

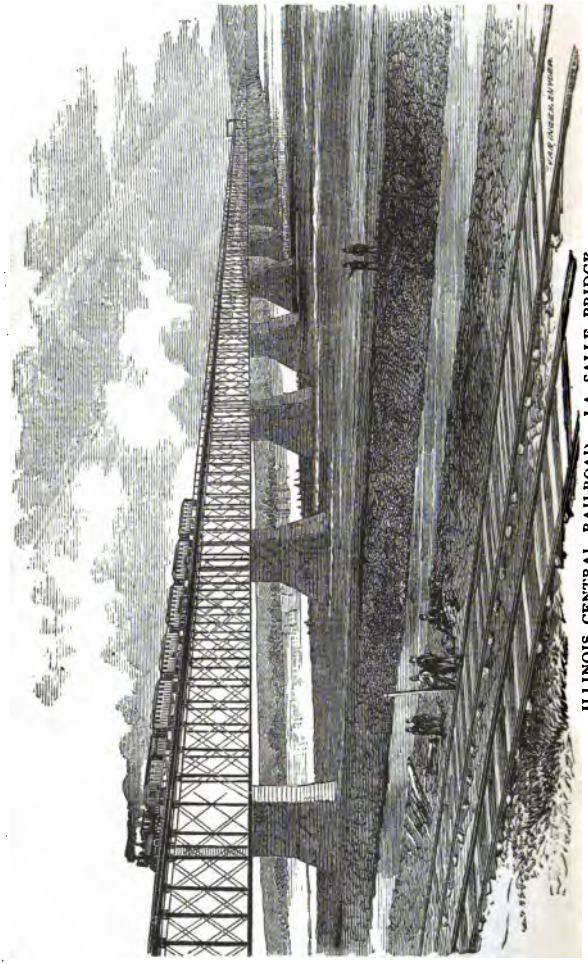


WEST-VIRGINIA. NEW RIVER BRIDGE ON ITS STAGING.

HUDSON RIVER RAILWAY BRIDGE AT ALBANY, N. Y.

these tests, the parts of the bridge are considered fit to be used.

When completed, the parts are put together—or "assembled," as the technical phrase is—in order to see that they are right in length, etc. Then they are marked with



ILLINOIS CENTRAL RAILROAD. LA SALLE BRIDGE.

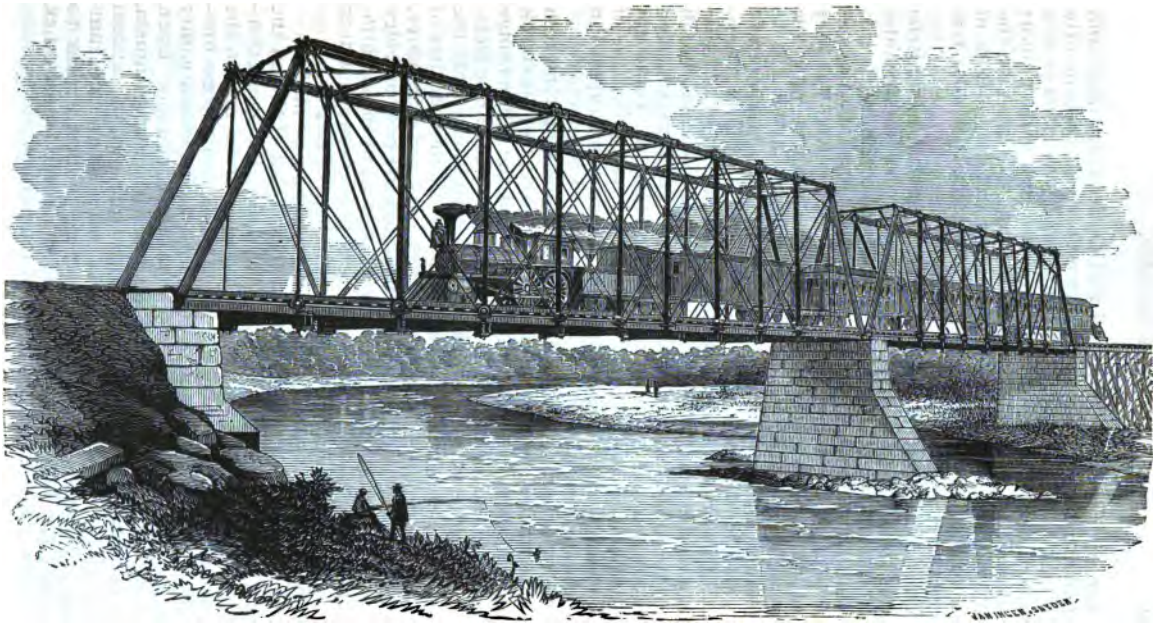
MAINE CENTRAL RAILROAD BRIDGE AT AUGUSTA, MAINE, OVER THE KENNEBEC RIVER. (211)

letters or numbers, according to the working plan, and shipped to the spot where the bridge is to be permanently erected. Before the erection can be begun, however, a staging or scaffolding of wood, strong enough to support the iron structure until it is finished, has to be raised on the spot. When the bridge is a large one, this staging is of necessity an important and costly structure. An illustration on another page shows the staging erected for the support of the New River bridge, in West-Virginia, on the line of the Chesapeake and Ohio Railway, near a romantic spot known as Hawksnest. About two hundred yards below this bridge is a waterfall, and while the staging was still in use for its construction, the river, which is very treacherous, suddenly rose about twenty feet in a few hours, and became a roaring torrent.

The method of making all the parts of a bridge to fit exactly, and securing the ties by pins, is peculiarly American. The plan still followed in Europe is that of using rivets, which makes the erection of a bridge take much more time, and cost, consequently, much more. A riveted lattice bridge one hundred and sixty feet in span would require ten or twelve days for its erection, while one of the Phœnixville bridges of this size has been erected in eight and a half hours.

The view of the Albany bridge will show the style which is technically called a "through" bridge, having the track at the level of the lower chords. This view of the bridge is taken from the west side of the Hudson, near the Delavan House in Albany. The curved portion crosses the Albany basin, or outlet of the Erie Canal, and consists of seven spans of seventy-three feet each, one of sixty-three, and one of one hundred and ten. That part of the bridge which crosses the river consists of four spans of one hundred and eighty-five feet each, and a draw two hundred and seventy-four feet wide. The iron-work in this bridge cost about three hundred and twenty thousand dollars.

The bridge over the Illinois River at La Salle, on the Illinois Central Railroad, shows the style of bridge technically called a "deck" bridge, in which the train is on the top. This bridge consists of eighteen spans of one hundred and sixty feet each, and cost one hundred and eighty thousand dollars. The bridge over the Kennebec River, on the line of the Maine Central Railroad at Augusta, Maine, is another instance of a "through" bridge. It cost seventy-five thousand dollars, has five spans of one hundred and eighty-five feet each, and was built to replace a wooden deck bridge which was carried away by a freshet.



PORTLAND AND OGDENSBURG RAILROAD. SACO RIVER BRIDGE, ME.

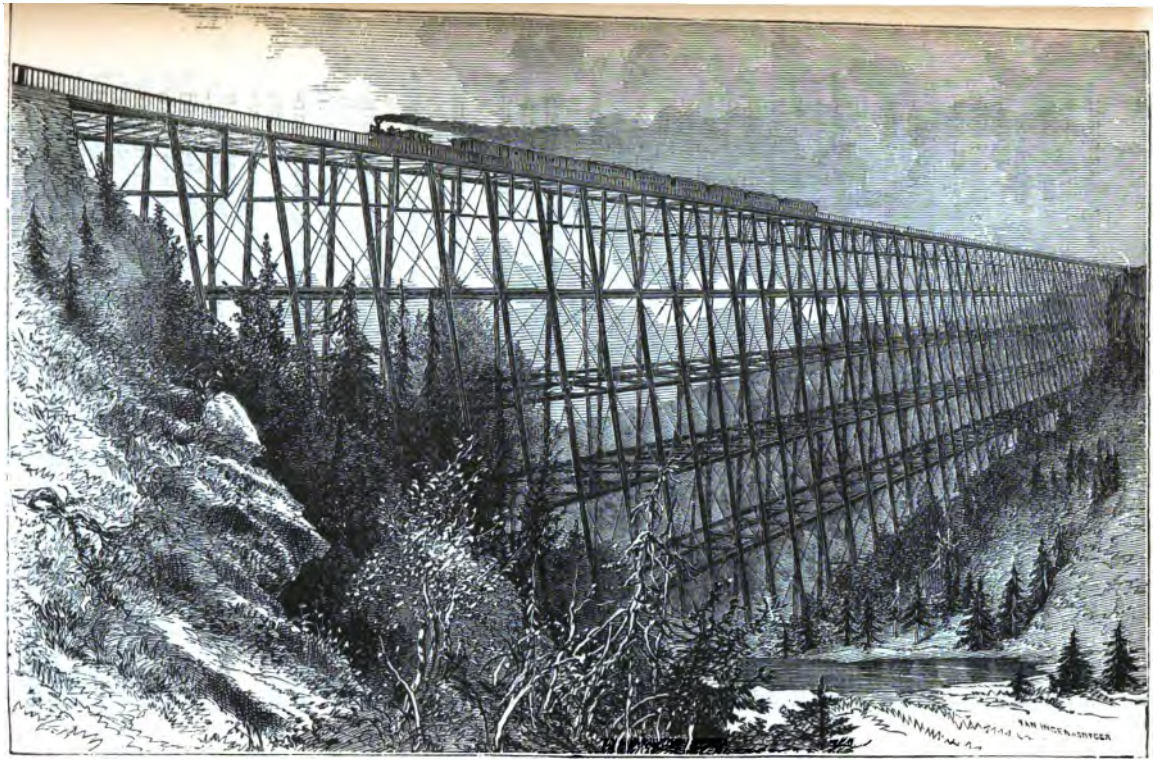
The bridge on the Portland and Ogdensburg Railroad, which crosses the Saco River, is a very general type of a through railway bridge. It consists of two spans of one hundred and eighty-five feet each, and cost twenty thousand dollars. The New River bridge, in West-Virginia, consists of two spans of two hundred and fifty feet each, and two others of seventy-five feet each. Its cost was about seventy thousand dollars.

The Lyman Viaduct, on the Connecticut Air-line Railway, at East-Hampton, Connecticut, is one hundred and thirty-five feet high, and eleven hundred feet long.

These specimens will show the general character of the iron bridges erected in this country. When iron was first used in constructions of this kind, cast-iron was employed, but its brittleness and unreliability have led to its rejection for the main portions of bridges. Experience has also led the best iron bridge-builders of America to quite generally employ girders with parallel top and bottom members, vertical posts, (except at the ends, where they are made inclined toward the centre of the span,) and tie-rods inclined at nearly forty-five degrees. This form takes the least material for the required strength.

The safety of a bridge depends quite as much upon the design and proportions of its details and connections as upon its general shape. The strain which will compress or extend the ties, chords, and other parts can be calculated with mathematical exactness. But the strains coming upon the connections are very often indeterminate, and no mathematical formula has yet been found for them. They are like the strains which come upon the wheels, axles, and moving parts of carriages, cars, and machinery. Yet experience and judgment have led the best builders to a singular uniformity in their treatment of these parts. Each bridge has been an experiment, the lessons of which have been studied and turned to the best effect.

There is no doubt that iron bridges can be made perfectly safe. Their margin is greater than that of the boiler, the axle, or the rail. To make them safe, European governments depend upon rigid rules, and careful inspection to see that they are carried out. In this country government inspection is not relied on with such certainty, and the spirit of our institutions leads us to depend more upon the action of self-interest and the inherent trustworthiness of mankind when indulged with freedom of action. Though at times this confidence may seem vain, and "rings" in industrial pursuits, as in politics, appear to corrupt the honesty which forms the very foundation of freedom, yet their influence is but temporary, and as soon



CONNECTICUT AIR-LINE RAILWAY. THE LYMAN VIADUCT, EAST-HAMPTON, CT. (215)

as the best public sentiment becomes convinced of the need for their removal, their influence is destroyed. Such evils are necessary incidents of our transitional movement toward an industrial, social, and political organization in which the best intelligence and the most trustworthy honesty shall control these interests for the best advantage of society at large. In the mean time, the best security for the safety of iron bridges is to be found in the self-interest of the railway corporations, who certainly do not desire to waste their money or to render themselves liable to damages from the breaking of their bridges, and who consequently will employ for such constructions those whose reputation has been fairly earned, and whose character is such that reliance can be placed in the honesty of their work. Experience has given the world the knowledge needed to build bridges of iron which shall in all possible contingencies be safe, and there is no excuse for a penny-wise-and-pound-foolish policy when it leads to disaster.—*Lippincott's Magazine.*

STATISTICS OF THE IRON INDUSTRY.

THE ninth census gives the following information relative to the iron industry of the United States, for the year ending June, 1870.

Pig-iron, 386 establishments, 574 blast-furnaces, (with a daily capacity of 8357 tons melted metal,) employing 27,554 hands, producing 2,052,821 tons of pig, of the value of $69,640,498.

Bloomary forges, 82, employing 2902 hands, and producing 110,808 tons of blooms, of the value of $2,765,623.

Foundries, 2653, employing 51,297 hands, and producing to the value of $99,837,218.

Forges, 103, employing 3561 hands, and producing to the value of $8,147,669.

Establishments producing bar, rod, and railroad iron, nail, plate, etc., 309, employing 44,643 hands, and producing to the value of $120,301,158.

TESTING LUBRICATING OILS.

A DEVICE for this purpose, suggested by R. H. Thurston, of Hoboken, N. J., consists of a hinged clamp having a screw to adjust the pressure upon the journal on which it is placed, with a thermometer to indicate the heating effect of a given amount of pressure and of revolution, while a spring scale attached to an arm projecting from said clamp indicates the adhesion or friction of the lubricated journal while in motion. This is a simple and effective device.

NEW-YORK AND BROOKLYN SUSPENSION BRIDGE.

IN the SCIENCE RECORD for 1872 will be found an extended account, with engravings, of a peculiar method of building the foundations for the piers of this great work, in the execution of which, it will be remembered, it was necessary to carry on operations at a depth of fifty feet below high-water mark. During the past year the foundations of the piers on both sides of the East River have been fully completed and the masonry carried up to a considerable distance above the level of the river. Those who desire the full particulars of the construction are referred to the RECORD of 1872. We now give a sketch of the bridge as it will appear when finished.

The height of the towers above high-water mark will be 268 feet; the height of the centre of the main span, by the same measurement, 135 feet; the length of the river-span, 1616 feet; of each land-span, 940 feet; of the New-York approach, 1441 feet; of the Brooklyn approach, 941 feet;

and the total length of the bridge will be 5878 feet. Thus it will be seen that it exceeds the dimensions of the largest suspension bridge now in existence. That at Niagara, whose main span measures about 1200 feet, is the next largest. The approach to the new bridge in this city will be on Chatham street, opposite the City Hall.

As the height of the bridge is to be only 135 feet above tide-water, the larger ships will have to send down their t'gallant masts in order to pass under the bridge.

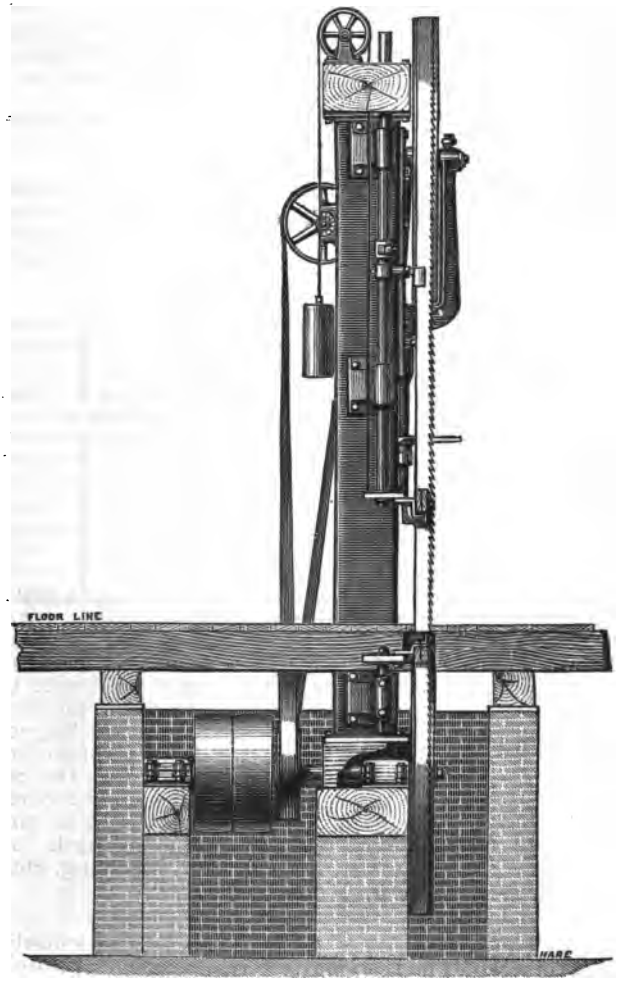
The entire weight of the bridge structure will be 4900 tons; and with heaviest load of snow and ice the total weight will not exceed 6100 tons. Each of the four main cables will have a strength equal to the support of 10,000 tons.

PROGRESS OF THE HOOSIC TUNNEL.

THE great railway tunnel through the Hoosic Mountain, near North-Adams, Massachusetts, is progressing very effectively, and it is probable that the bore will be completed in October, 1873. The boring has for the past year or more been carried on at four headings, one on each side of the mountain, and two in opposite directions, from the bottom of a vertical shaft which is sunk near the middle of the mountain. The 12th of December, 1872, was an eventful day among the workmen. After some unusually heavy blastings, a junction of the two headings between the east end of the tunnel and the central shaft was then effected, greatly relieving the contractors by the immediate drainage of the water from the central shaft. The central shaft is 1030 feet in depth, and, since the junction was made, it is found to operate like an immense chimney, producing a strong draft through the whole length of the eastern section of the tunnel, a distance of nearly two and a half miles. The total length of the tunnel will be almost five miles. It is the second longest tunnel in the world, the Mount Cenis bore, through the Alps, being nearly eight miles in length. But the St. Gothard tunnel, through the Swiss Alps, which was commenced during the present year, will beat both of the above, as it will be thirteen and a half miles in length. A full account of the Hoosic Tunnel, with engraving, etc., was given in the SCIENCE RECORD for 1872.

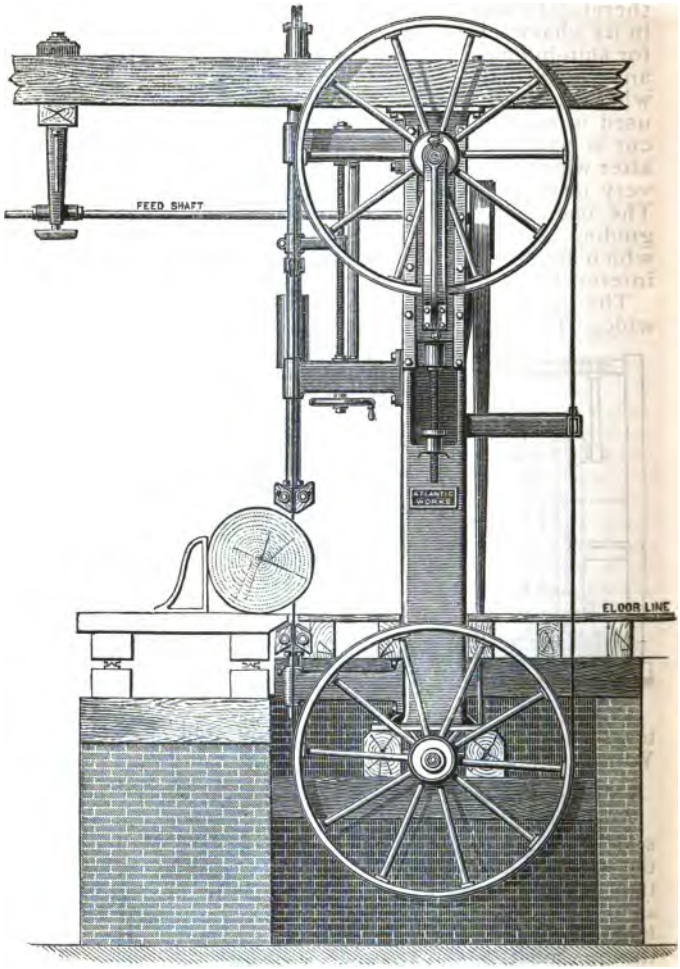
ALLOY FOR TELEGRAPHIC WIRE.—An alloy particularly suited for wire for telegraphic lines may be made, as stated by C. J. A. Dick, by mixing with copper from two to five and a half per cent of tin free from oxide, and from one eighth to one half of one per cent of phosphorus. This will make a strong wire of good conducting qualities.

BAND-SAW MILL.



BAND-SAW MILL. BY RICHARDS, LONDON & KELLEY.

THE band-saw mills of J. J. Van Pelt, Esq., of New-York, are no doubt the most extensive experiments yet ventured

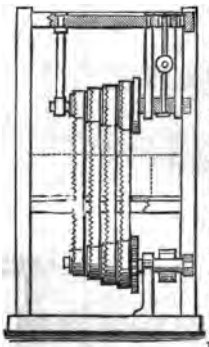


BAND-SAW MILL. BY RICHARDS, LONDON & KELLEY.

upon for log-cutting. The sawing-machinery was constructed by Richards, London, & Kelley, of Philadelphia, upon plans very much at variance with those that had

theretofore been followed. The mill is quite anomalous in its character, being intended for cutting long timber for ship-building, to follow the curvature of long timber, and cut with the grain, and other uses. The carriage is what is termed a "central" hard-block carriage, such as is used in our old style reciprocating-saw mills. The first cut is made by adjusting the log as the saw progresses, after which the slab face is carried past permanent gauges, very much on the principle of common hand-slitting. The operation involves various devices for supporting, guiding, and setting the log, invented by Mr. Van Pelt, which are, however, of too special a character to have any interest here.

The blades used are from 55 to 60 feet long, 5 inches wide. The pulleys are 75 inches diameter, including hubs of wrought-iron; they are covered with lagging of pine, over which is glued a covering of heavy harness leather. The bearings are, for the wheel-shafts, 4 inches diameter, 12 inches long, made of six parts copper and one tin. The speed of the saw is about 4500 feet a minute, the tension from one to four tons. It may be mentioned as a fact of interest that the wheels first used were of cast-iron, which were in a few days crushed with the strain of the saw, and had to be replaced with wrought-iron wheels, a plan which the builders have since carried out in all their machines.



Our small diagram shows an arrangement for a gang of band-saws recently designed by W. J. McLane, of New-York.

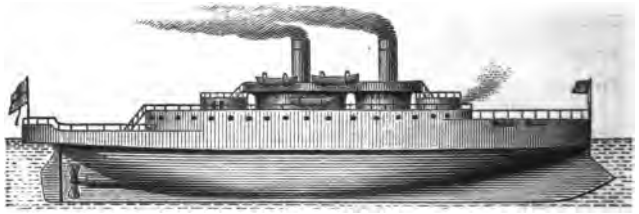
ANTIQUITY OF THE MANUFACTURE OF IRON.

THE antiquity of the manufacture of iron on a large scale is shown in an article by Mr. Richard Mallet, upon the working of iron in India, where, according to this author, it had been carried on upon a scale so stupendous as to rival the production of the largest steam-hammer forges in Europe at the present day. Among other illustrations mentioned is that of a wrought-iron pillar at the principal gate of the ancient mosque of the Kutub, near Delhi, which is as large as the screw-shaft of a first-class steamer. This is slightly spindle-shaped, and is surmounted by a capital of elaborate Indian design, carved by the chisel in the solid iron. The entire length is about sixty feet. Its diameter near the surface is sixteen inches;

it contains about eighty cubic feet of metal, and weighs upward of seventeen tons. Near its middle is an inscription of six lines in Sanscrit, from which its age has been assigned to the third or fourth century of the Christian era.

H.M.S. THUNDERER.

THIS powerful iron-clad, recently launched at Pembroke, England, is a sister vessel to the Devastation, and is one of the mastless sea-going turret-ships designed by Mr. Reed, and is considered to be one of the strongest vessels in the world. The English now have a fleet of these ships, and no other nation at present possesses vessels of equal strength.



THE BRITISH IRON-CLAD "THUNDERER."

The armament of the Thunderer consists of four 35-ton guns, bore 12 in., carried in two turrets, and differing only in details from those of the Glatton, illustrated in last year's SCIENCE RECORD. The projectiles weigh 700 lbs., and the battering charge is 120 lbs. of powder. The armor generally is 12 in. thick, but 14 in. in the neighborhood of the portholes. On the sides of the breastwork, between the turrets, where no shot, penetrating by a direct blow, could harm the machinery of the turrets, the thickness is 10 in., and the lower strake of armor on the sides, under water, is also reduced to 10 in. At the ends there is a certain amount of taper, as usual. The armor overhangs the sides, as in Ericsson's monitors, partly for structural convenience, partly to obtain the steadying bilge-keel action of the projection, and partly for greater protection of the bottom from rams. The deck is 3 in., 2 in., and $1\frac{1}{2}$ in. thick, according to its position and height above water. The backing (teak) varies from 15 in. to 18 in. The tonnage is 4406 tons; displacement, 9117 tons; coal supply, 1600 tons; speed, 13 knots, probable, or 10 knots sustained for over 4000 miles. There are no masts, (except for signalling and handling boats,) and the engines—of 800-horse power nominal, guaranteed to indicate 5600—drive inde-

pendent twin screws. The vessel has a sharp spur, and is short, broad, and handy. After this enumeration it is hardly necessary to say that, as regards fighting, there is as yet no floating thing, abroad or at home, save her sister the Devastation, which could dream of measuring powers with the Thunderer.

The following are the principal dimensions of the Thunderer:

			ft.	in.
Length between perpendiculars			285	0
" of keel for tonnage			246	3⅝
Breadth extreme			62	3
" for tonnage			58	0
Depth in hold			18	0
Burden			4406	tons.
Displacement			9117	"
Area of midship section			1464	sq. ft.
			ft.	in.
Draught of water, forward			25	9
" " aft			26	6
Height of port from load water-line, fore turret			13	6
" " " after "			13	2
Freeboard, forward			9	3
" amidships			11	5
" aft			4	6
Depth of armor below water, amidships			5	0
Height of armor above water-line.	On sides	Forward	0	6
		Amidships and aft	4	2
	On breastwork	At fore end	11	9
		Amidships	11	5

		Armor.	Backing.
Thickness of armor and backing.	On sides	12 & 10 in.	18 in.
	On bulkheads at break of deck	12 in.	16 in.
	On breastwork	12 & 10 in.	16 & 18 in.
	On turrets	14 & 12 in.	15 & 17 in.
Thickness of skin plating behind armor.	On sides		1⅛ & ¾ in.
	On bulkheads at break of deck		1⅛ in.
	On breastwork		1¼ in.
	On turrets		1¼ in.
Thickness of deck plating.	On monitor deck		3 in. (2 in. aft.)
	On deck over breastwork		1 in.*
Engines, nominal horse-power			800
" indicated "			5600
Estimated speed			12.5 knots.
Complement of officers and men			300
Armament, four			35-ton guns.

	tons.		
Weight of armament	512		
" crew and ship's stores	254		
" engines and engineers, stores, with water in boilers	967		
" coals	1600		
" turrets	592		
" pilot tower	110		
" deck plating and glacis plates	522		
" armor, in other parts	1542		
" backing	256	tons.	
		6355	
" hull		2454	
		8809	
Probable surplus		308	
		9117	

* Since increased.

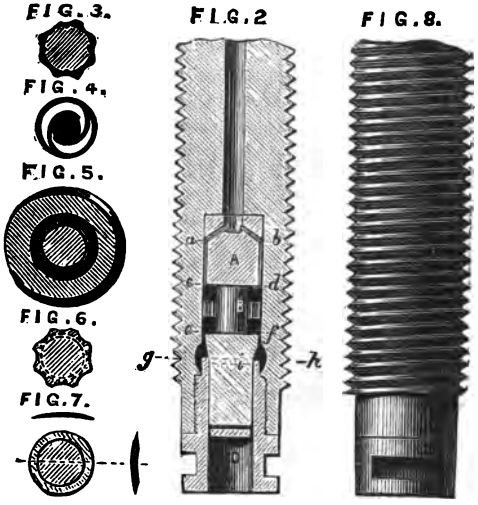
GUNPOWDER PRESSURE-GAGES.

AMONGST the various investigations to which the great increase in the dimensions of modern artillery has led, is that relating to the pressure exerted within the bore of the gun by the ignition of the powder charge. The object with which the experiments in this direction were instituted was to determine the kind and quantity of the powder best suited for heavy guns. The Committee on Explosions, having the arrangement of the experiments, used the Rodman pressure-gage in the first instance. This gage, we need hardly say, comes to us from the United States, having been devised by Major Rodman, the designer of the cast-iron gun bearing his name. This gage is shown at Fig. 1, and in using it a hole is drilled through the gun at any point in the bore where it is desired to ascertain the pressure exerted by the exploding charge. Into this hole the tube A is screwed, its lower end, which is open, being flush with the bore. The other end is closed with the piston B, the joint being rendered tight by means of the gas-check C. The piston carries a knife D, and upon the knife rests a piece of copper E, which is held tightly against it by the screw F. When the charge is ignited, the pressure of the gases on the base of the piston forces the knife into the copper, and the indent produced is held to be the measure of the pressure which has acted upon the base of the piston.

Fig. 1.

The results, however, which were obtained with this apparatus were so exceedingly variable that the committee were led to devise a modified form of pressure-gage in which some of the causes of error inherent in the Rodman gage were eliminated. The crusher-gage, as it is termed, is shown at Figs. 2 and 8, our illustrations having been prepared from drawings from the British War Department. This apparatus was made in the Royal Gun Factories, and consists of a screw plug of steel provided with a movable

base, Fig. 3, which admits of the insertion of a small cylinder or pellet of copper B, in the chamber *c, d, e, f*. One end of this cylinder rests against an anvil A, the other being acted upon by a movable piston C, which is kept well up to the cylinder by means of a small spring *i*. The copper cylinder is retained in a truly central position within the chamber by means of a small watch-spring seen at Fig. 5. In order to prevent any possible leakage of gas into the chamber, the head of the piston is fluted, as seen at Fig. 7, as is also the body of the anvil, Fig. 4. Four small holes, *a, b*, Fig. 3, communicate with a main vent passing through



the upper portion of the plug. Against the lower extremity of the piston, a gas-check D is inserted. The crusher-gage is used in exactly the same way as the Rodman gage, being inserted at any required point in the bore of the gun. In the eight-inch experimental gun the pressures are taken at intervals along the whole length of the bore, holes being drilled for that purpose. As the gases expand, following up the flight of the projectile, the pressures become weaker, the reduction gradually increasing toward the muzzle as the expansion increases. The forward gages are therefore provided with cylinders made from a softer metal than those used at the immediate point of explosion. In the thirty-five ton gun, the pressures are taken at three points, at the end of the bore, at the vent,

and at the base of the projectile. The gage for the end of the bore is placed in the centre of a shallow copper pan which is inserted at the muzzle of the gun and carefully pushed down the bore by means of a detachable rod, the same implement being used to withdraw it after a charge has been fired. The vent-gage is inserted in the vent-hole, while that for the projectile is placed in a hole made in the base to receive it. The gun is fired by electricity, the wires being inserted in the powder-charge before it is placed in the gun. To prevent jamming, they are laid along a groove cast on the outside of the projectile, both powder and shot being rammed carefully home together. The action of the apparatus is very simple. Upon the explosion of a charge, the gas acts on the area of the piston and crushes the copper cylinder against the anvil. The amount of compression which the copper thus sustains becomes an indication of the pressure exerted upon the piston. The area of the copper cylinder found most suitable for the eight-inch gun is one twelfth of an inch, the piston area being just double or one sixth of an inch. In order to obtain data whereon to base the calculations of the pressures, a series of experiments were made, by means of a testing-machine, to determine the pressure required to produce a definite amount of compression in copper cylinders similar to those used in the instrument. The results of these experiments were tabulated, and they furnish a means of comparison whereby the amount of compression produced in the crusher becomes a direct indication of the pressure exerted by the gases at that part of the bore or chamber where the gage is placed.

The results of experiments show that, in the case of R. L. G. (rifle large grain) powder, the indicated pressure was from 22½ tons to 40 tons per square inch.

During the year 1870, the Russian Government instituted a series of experiments in this direction with 6, 8, 9, and 11-inch breech-loading rifles, and 15-inch muzzle-loading smooth-bore guns. The object of the experiments was to ascertain the comparative action of grain and prismatic powders in heavy charges, and also to determine the charge suitable for each class of guns. The pressures varied with the charges and projectiles, from 11 tons to 18 tons per square inch.

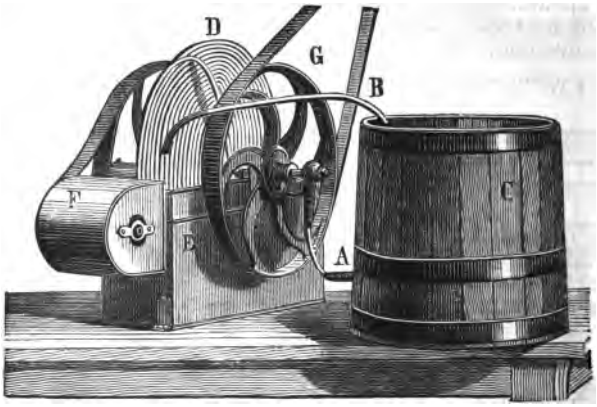
These experiments led to the decided preference of prismatic as against grained powder. With equal velocities, the grained powder developed more than twice the pressure obtained with the prismatic powder. This wide difference, however, was only developed when the velocities were very high; and the higher these ranged, the greater

the difference of pressure became between the two powders —always showing in favor of the prismatic. The experiments also indicated the great importance of the size of the diameter of the cartridge in muzzle-loading guns, and of the length of the powder-chamber in breech-loaders. For instance, in the 15-inch gun, the velocities were equal with charges of 75 pounds and 100 pounds, when the diameter of the first was 12 inches, and that of the last 9.7 inches. (28)

IMPROVEMENTS IN BLASTING.

T. KLERITY, a German engineer, has lately introduced an improved blasting-cartridge, which is said to save much powder or dynamite, and seems to be worth notice. The new feature of it consists of a cast-steel cylinder, which is inserted in the cartridge, and replaces a part of the powder, which is ignited through a touch-hole in the cylinder. At both ends the cylinder is very near the calibre of the bore-hole, but its middle part, for about two thirds of the whole length, is reduced to half that diameter. This thin part has a channel bored through it at right angles to its axis, while another vertical channel follows the axis from the top until it reaches the transverse passage, both of which are filled with fine-grained powder and ignited in a suitable way. The length of the steel cylinder is 12 or 14 inches, and its diameter 1 to 1½ inches at the ends, and ½ to ¾ inch in the middle. It is inserted in a cylindrical paper bag, and the powder of dynamite filled between the reduced diameter and the paper; it is then placed in the bottom of the blast, covered with a certain thickness of tamping, and fired in the usual way through the channel in the centre. Another improvement with the use of dynamite has lately been made at Raibl, in Carinthia, where the dolomitic limestone is very cavernous, and much of the power of the explosive is lost, its gases expanding uselessly into these cavities. In order to prevent this, a watertight dynamite cartridge is introduced into the bore-hole, and before firing it, as much water pumped into the same as it and the next adjoining cavities would hold. Through this very simple expedient, a wonderful effect is said to have been produced, by which half of the former expenses of blasting were saved.

SEWING-MACHINE.—A number of different methods of employing water-power for driving sewing-machines have been proposed, and one of the latest is that suggested by Isaac Hyde, who attached direct to the main shaft of the machine, a small water-wheel, inclosed in a case and provided with suitable inlet and exhaust pipes. The speed of the wheel is governed by a valve operated by a treadle.



DYNAMIC REFRIGERATOR.

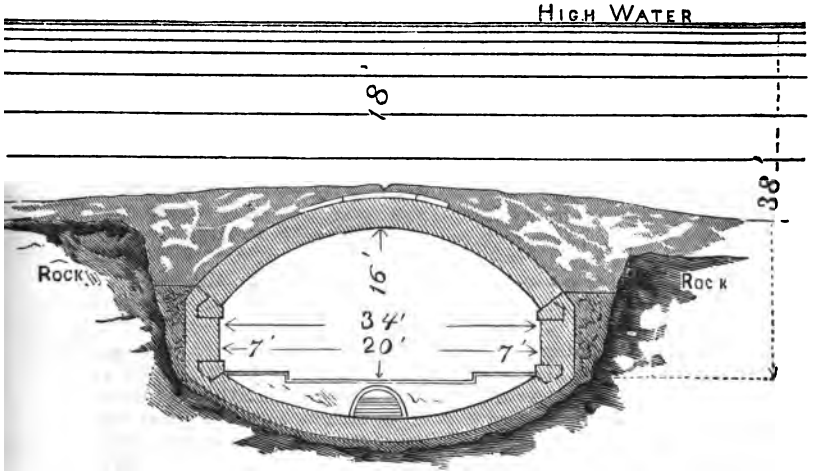
By J. B. Toselli, of Paris, France.—It consists of a revolving disk D, formed of a metallic tube bent into a complete spiral, having one end open, and with the other end communicating by a hollow shaft or axis of rotation with an external tube A, communicating with a worm contained in a separate vessel C, and terminating in a discharge-pipe B, with outlet into another vessel E, containing the revolving disk, to which a slow movement of revolution is imparted by a driving-pulley and belt G, making, say, one turn in a second of time. The disk is half immersed in cold water, and as the exterior surface above water is continually wet, it exposes considerable evaporating surface. At the same time a continuous stream of water is forced through the hollow spiral, parting with some of its heat under the influence of the external evaporation and radiation, which is intensified by the addition of a ventilator F.

The current, being thus lowered in temperature, refrigerates in its turn the liquid to be cooled in the vessel C. The lowering of temperature thus obtained varies according to the hygrometric condition of the atmosphere; the minimum effect obtained, under the most unfavorable circumstances, amounts only to a difference of 5° to 6° Fah., while the maximum difference obtained in sunlight is between 32° and 33° Fah.

This machine is obviously calculated to be of great service in many manufacturing processes—such as for brewing, distilling, and effervescent beverages—also in hydro-

therapeutic establishments; and probably also on shipboard, for the evaporation and distillation of sea-water, and its conversion into a potable fluid. (74)

NEW TUNNEL UNDER THE HARLEM RIVER.



SECTIONAL ELEVATION OF THE NEW TUNNEL UNDER HARLEM RIVER.

AMONG the public improvements now in process of construction in New-York City, is a tunnel and roadway under the Harlem River, at the northerly end of the city. This important work will form a continuation of the elegant thoroughfare known as Seventh avenue, which, by means of this structure, will be carried under the river into Westchester County. The approach on the New-York side begins at 150th street, four blocks from the river shore, and the Westchester approach beginning at 163d street, at about the same distance from the water's edge. The length of the tunnel from one extreme to the other will be 2641 feet.

At 150th street the road-bed and sidewalks on Seventh avenue begin to gradually descend, the sides being built up with handsome blue granite. 151st street will be closed, at least for the time being, but at 152d street the tunnel will have reached a sufficient depth to allow a bridge to be thrown across on a level with the natural ground-surface of Seventh avenue. At the beginning of the next block the tunnel will be entirely closed overhead,

while the descent continues until the river is reached and the water is found to be directly overhead. At this point the tunnel is built through the solid rock, in order to leave a sufficient depth of water overhead for the navigation of large vessels. As soon as the opposite side of the river is reached, the tunnel ascends until the level of 163d street is reached.

The tunnel, when completed, will be simply a well-made street, with two sidewalks, each seven feet wide, and a carriage-way twenty feet in width. Just above 153d street there is to be a large square opening for foot-passengers. A staircase, fourteen feet wide, leads down to the top of the tunnel, where there is a landing from which two stairways descend, leading to both sides of the street below. Between 154th street and the river will be another opening forty-eight feet in diameter, with similar stairways leading down to the tunnel.

The next opening for passengers is near the shore, on the Westchester side. Near Sedgwick avenue, a short distance beyond, there will be another small round opening for passengers. There are also four more openings, at intervals, to admit air or light. The tunnel does not run under the river in a straight line with Seventh avenue, but turns to the right of 155th street, and crosses at right angles with the river, in a direction almost due northeast. (94)

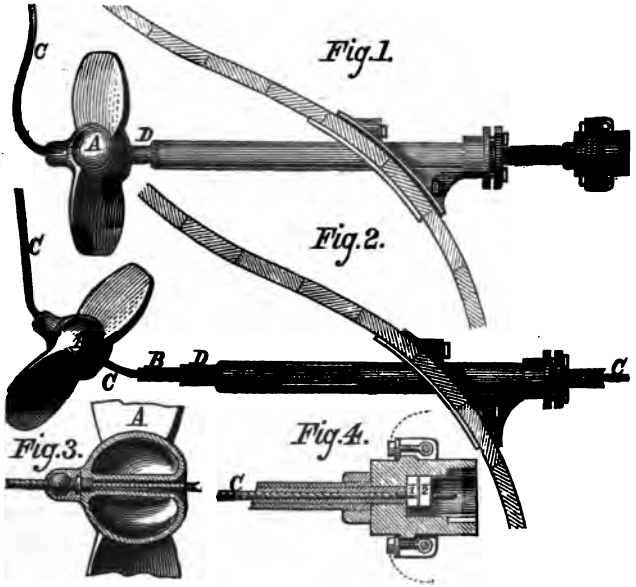
MANUFACTURE OF AXES.

M. LOUIS LA BRECHE VIGER, of Montreal, has suggested a new method of manufacturing axes, hammers, and other implements, by first making them of wrought-iron, and then converting them into steel. The articles to be treated are immersed in a bath of molten cast-iron free from sulphur and phosphorus, and carburized to its utmost capacity. The best for that purpose is spiegeleisen, but such cast-iron may be made by melting good malleable iron or blister steel in a cupola furnace. The articles are left in this bath a space of time, which must vary with the degree of hardness desired to be imparted to the metal and with the size of the articles, and also according to the intention of converting the whole mass of the metal into steel, or simply of converting the surface so as to contain a core of malleable iron.

SAFETY OIL-TANKS.—As a means of extinguishing fires in tanks in which oil is stored, Homer Baker, proposes to place over the oil a series of perforated pipes, through which carbonic acid may be forced, which, being heavy, will settle on the oil and prevent its burning.

AUXILIARY SCREW PROPELLER.

BY MR. GEORGE LEACH, OF LEEDS.—The object of this improvement, which is the design of G. Leach, of Leeds, England, is to give to existing sailing vessels sufficient power to enable them to steam five or six knots an hour during calm weather, or to make headway against currents or light winds. One of the great advantages claimed for the arrangement is that it can be fitted easily at very small expense; whilst, when not required, the screw can be hauled on deck, and the screw-shaft run back into the vessel in a short space of time. It is needless to point out how large a field for the application of this arrangement is to be found in the fleet of sailing colliers and fishing vessels.



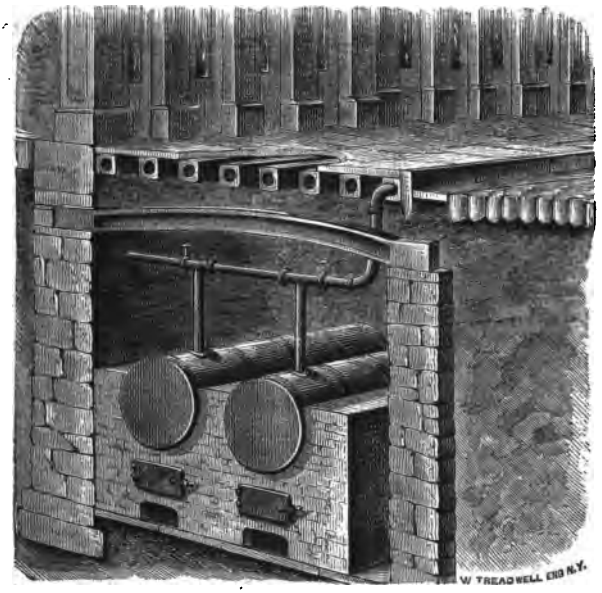
In the above illustration, Fig. 1 represents part of a ship's quarter with the propeller in place; Fig. 2 is another view representing the propeller unshipped, and being hauled up on board by means of the rope C.

In Figs. 3 and 4, the boss A of the propeller, and also the propeller-shaft, are shown in section. Through the central part of this boss A, a tapered hole is formed, as shown in Fig. 3, to correspond with the tapered end B,

of the hollow shaft D, on which the propeller is mounted when in use. The tapered hole in the propeller boss is enlarged and extended at the front or leading end into a trumpet-mouthed shape, for the purpose of facilitating the entrance of the tapered end E of the shaft, and guiding it into the boss. In the after or outer end of the tapered hole, there is a socket, into which is screwed a plug, to which a wire rope, C, is secured, and passes out through the trumpet mouth, and through the hollow shaft E into the vessel. Another rope C, is attached to a ball, which works in a spherical socket, as shown in Fig. 3, so that when the propeller is detached from the shaft, it may be suspended by the two ropes C. The rope which passes through the hollow shaft to the inside of the vessel is secured there, so that, by hauling upon this rope, the propeller may be drawn upon the taper end of the hollow shaft, securely held there, and afterward jammed up tight by means of the compound jam-nut, 1, 2. When it is desired to unship the propeller, the strain upon the hauling rope C must be relieved, and the outer shaft driven out against the boss of the propeller, so as to ease off the boss from the tapered extremity of the inner shaft. An additional length of rope is then temporarily connected to the inner end of the rope, when the propeller can be hauled on deck. The end of the rope must then be secured on board ready to be connected with the propeller again, when it may be required to reverse these operations, and to reship the screw on its shaft. (28)

LIFE-BOAT.

MR. N. J. HOLMES, engineer of the Orkney and Shetland Islands Telegraph Company, writes to the London *Times* in regard to the subject of life-boats, and states that three valuable lives having recently been lost by the swamping and sinking of an open boat with stone ballast, he had recently built a life-boat thirty feet long by eighteen feet broad, which he had found to be unsinkable, and requiring no ballast, being in every respect a life-boat. This is the form of the safety-boat invented by Captain John Moody, built on the "ray" principle, drawing only seven inches of water, carrying no ballast, self-emptying, and "as stiff as a steeple" in a gale of wind, with a fifty foot mast and ample sails. He has been employing her in very dangerous work, repairing the heavy shore end of the Great Northern Telegraph Company's cable in the North Sea, under circumstances when an ordinary boat must have capsized. Another improved life-boat, tried in England with success, is decked over and propelled by a screw by men inside the boat, under cover.



REMOVING SNOW FROM SIDEWALKS.

It is suggested, as a convenient means of clearing snow from sidewalks in cities, that an arrangement of hollow brick pipes be laid directly under the pavements, and that such pipes be connected with a heater, so that steam or hot air may be sent through the pipes, for the purpose of warming the pavement and melting off the ice. Such an arrangement is shown in our illustration. In our large cities, most of the buildings on the principal streets are provided with steam-boilers for heating purposes, and this proposed device could, therefore, be easily brought into use. It is noticeable that the pavements of sidewalks in front of shops, wherein the basement floor extends out under the walk, are always warmer and the ice melts more quickly, than on walks where there is no such basement extension.

Mr. R. B. Miller, of Utica, New-York, has suggested the laying of steam-pipes under the tracks of the horse railways, and the driving of steam therein, for the purpose of melting the snow in winter, preventing the freezing and bursting of water-pipes, etc.

Another ingenious individual has obtained a patent for

laying steam-pipes in canals, with a view of preventing the formation of ice, and thus maintaining navigation the year round.

Another disciple of ingenuity proposes to keep the tracks of ferry-boats open on rivers in winter, by using iron ferry-boats, having double bottoms, a space between the bottoms to be filled with steam. The warmth therefrom is expected to prevent the river water from freezing on the track of the boat.

EXPLOSIONS IN FLOUR-MILLS.

The Engineer gives the results of an inquiry conducted by Professor Rankine and Dr. Macadam, on behalf of the fire insurance offices, into the circumstances which probably led to the explosion of the Tradeston Flour-Mills, near Glasgow, in July last. The primary cause of the explosion was the accidental stoppage of the feed of a pair of stones, which led to their becoming heated and striking fire. This inflamed the finely divided dust diffused through the air of the exhaust-conduits, the fire passing on to the exhaust-box. The sudden ignition of the extremely inflammable dust diffused through the air would produce a very high temperature, and would necessarily be accompanied by a gust and sudden increase, in pressure and bulk, of the gaseous products of the combustion. The effect of this explosion was to burst the exhaust-box, and allow a diffusion of dust and flame through the mill. A second explosion was the consequence, and the mill was reduced to ruins. The authors determined by direct experiment the interesting fact that this mixture of air and dust, when in the proportion best suited by theory to cause an explosion, produces, by being fired in a limited space, a pressure of eight atmospheres.

THE REFFYE CANNON.

THIS piece, so called the Reffye, after its inventor, is a gun recently employed in the French artillery; it is a breech-loader, and can throw a projectile weighing 7 kilogrammes (15.4 lbs.) for a distance of 5500 yards.

This gun combines the lightness and portability of field-pieces with the accuracy and range of siege-guns of average calibre. The grooves are numerous, in order that an equal action may be imparted to the whole surface of the lead-covered projectile. The gun is of bronze made of 100 parts of copper to 11 of tin. The total length of the piece is 6 ft. $8\frac{3}{4}$ inches, the diameter of the bore is $3\frac{5}{16}$ inches, and the weight of the complete weapon is 1320 pounds. The charge is divided into two parts, the cartridge and the projectile, their respective lengths not per-

mitting of their being united. Forty-two ounces of compressed powder, arranged in disks, form the charge, which is placed in a metallic envelope, the net price of which, complete, is 1.10 francs. As to the projectile, it is cylindro-conical, of cast-iron, 9½ inches long, and covered with a zinc envelope. The shells are ignited by a percussion fuse. This type of ordnance, rendered celebrated during the defense of Paris, principally on the plateau of Avron, will play an important part in the future of French artillery.

EVAPORATIVE EFFICIENCY OF BOILERS.

THE American Institute committee, New-York, appointed to decide upon the merits of exhibited boilers, consisted of R. H. Thurston, Professor of Mechanical Engineering at the Stevens Institute of Technology, Chairman; and T. J. Sloan and Robert Weir, well-known engineers, Members. To secure an accurate determination of the amount of water passing out of the boilers, both evaporated and unevaporated, it was led into a large surface condenser. The weight of the water of condensation and of the condensing water was exactly measured, and the temperature of the water of condensation and the condensing water, of the steam in the boiler and of the entering feed and injection water, was obtained by delicate thermometers. The greatest care was taken to insure such accurate determination as should make the results of these trials valuable as *standards* with which to compare those of future similar trials. The log was kept by students selected from advanced classes of the Stevens Institute of Technology, and under the supervision of the chairman, himself a professional and experienced engineer. The committee thus obtained results that are extremely valuable to the engineer, as exhibiting the true efficiency of what they considered good boilers of quite dissimilar forms, and hardly less useful to the phycisist, as giving the modulus of efficiency of large evaporating apparatus. The arrangement described enabled a determination of the quantity of heat transferred to the condenser from each boiler, during its twelve hours' trial, to be readily made. The weights of coal and wood were also recorded as is usual. To ascertain the weight of water actually evaporated and that carried over unevaporated, the committee use the formula, $Hx+h(W-x)=U$, where H is the number of thermal units transferred by each pound of steam, h the thermal units carred over to the water of condensation by a pound of water, x the weight of steam, and $W-x$ the weight of water by which the

total quantity of heat U is transferred from boiler to condenser.

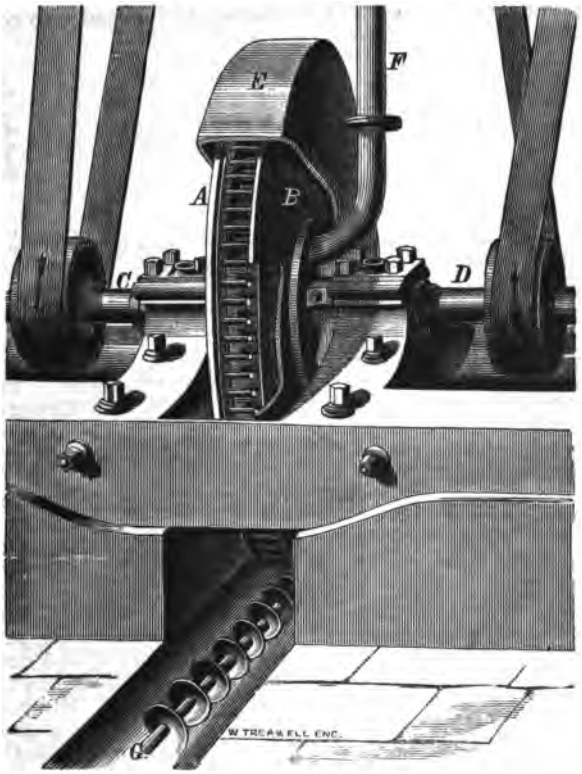
Name.	Style.	Area of Heat Surface.	Square feet required to evaporate one cubic foot per hour.	Ratio H. S. to grate area.	Percentage of water primed.	Temperature of flues.	Evaporation per lb. combustible feed 212° F.	Modulus of Efficiency.
Root.....	"Sectional*"	876½	23.59	32.5	0.00	416.6° F.	10.64	0.709
Allen.....	"Sectional*"	920	17.41	28.5	0.00	345.8° F.	10.60	0.707
Phleger...	"Sectional*"	600	22.74	26.1	3.26	503.7° F.	10.49	0.699
Lowe.....	"Tubular†"	913	21.63	24.2	6.90	389.6° F.	10.40	0 693
Blanchard	"Tubular‡"	440	33.48	51.8	3.00	221.6° F.	11.34	0.756

ELECTRO-RECORDING BAROMETER.

H. C. RUSSELL, of Sydney Observatory, New South-Wales, describes in *Nature* his recent improvement. The barometer tube is an ordinary glass one, 0.58 in diameter, and is fixed firmly to the case. Its cistern is a small glass one, one inch in diameter, and cemented to a brass arm hinged to the left side of the case, which allows it perfectly free mot on up and down, but not sideways. From this cistern projects a very light arm, also hinged, and bent at the end so as to extend over the inclined plane. One wire of the battery is attached to the cistern-arm, and the other, after passing round the magnet, to the inclined plane. As soon, then, as these two parts touch, the electro-magnet brings down the brass frame, and with it the pen, on to the paper which at once begins to mark, and continues to do so until the motion of the clock draws the inclined plane from the cistern-arm, and so breaks the contact; the pen remains off the paper until, by the motion of the clock, the inclined plane is brought to touch the projecting cistern-arm, when the pen at once begins to write.

As the barometer, when the pressure increases, must draw the mercury for its increased height from the floating cistern, the cistern becomes lighter, and rises with it, and the smallest motion may be made sensible by altering the inclination of the moving inclined plane. The accuracy of the motion of this plane is secured by making it work on two fine steel points—the same motion, in fact, is that given to the cutter of a dividing engine. The cistern floats in a reservoir of mercury. The pen is a siphon pen, supplied with thin ordinary writing-ink.

* Wrought-iron tubes.
† With special provision for perfect combustion.
‡ Feed-water heater and mechanical draught.



THE DISINTEGRATING FLOUR-MILL.

MR. THOMAS CARR, of Bristol, England, is the inventor of the distintegrating mill, which is stated to have been applied in practice with success for various purposes. Percussive instead of grinding force is employed, and the most novel use of the apparatus is the manufacture of flour from wheat. Our engraving gives a general view of a seven-foot disintegrating flour-mill, various portions being represented as broken away in order to show the interior arrangement of the working parts. A and B are circular metal disks, which rotate in contrary directions upon the shafts C and D, which are situated in the same line. On the inner surfaces of these disks are concentric rings or projections, called beaters, the rings on one disk

intervening alternately with those on the opposite disk and moving in a contrary direction. Several concentric rings of beaters may be thus made to operate conjointly.

The revolving beaters are inclosed in a casing E. The grain is delivered down the fixed shoot F, through the orifice in the outer casing, into the innermost cage, from which it is instantly projected by centrifugal action through the machine and delivered in a shower radiating from every portion of the circumference, into the outer casing, in the form of a meal similar to that thrown out by the ordinary millstones; to this state the grain is reduced almost instantaneously by being dashed to the right and left alternately by the bars of each of the succesive cages revolving in opposite directions at a very high rate of speed. As it falls to the bottom of the casing, the meal is continually removed by the ordinary rotating screw G used in flour-mills; it is then passed through the usual bolting-machines, to separate the bran, and subsequently through silk-dressing machines to separate the fine flour from the semolina. The latter is then winnowed by an exhaust current of air in a machine for that purpose, so as to free it from all finely-powdered bran, and is afterward ground between millstones, of which three or four are kept for the purpose; the flour resulting from it is added to the fine flour produced at the outset by the disintegrating flour-mill, and to insure perfect intermixture, the two are then passed through the silk-dressing machines together.

The machine is driven at a speed of about 400 revolutions per minute; and the outermost ring being 6 feet 10 inches diameter, the last beaters have a velocity of 140 feet per second, or about 100 miles per hour.

Foreign substances which would prove of great injury to millstones are readily thrown out by the centrifugal force in this machine. The work accomplished by a machine of this description, of 6 feet in diameter, is stated to amount to 160 bushels of wheat per hour, which would require as many as 27 pairs of ordinary millstones, taking the average duty of each at six bushels per hour. The Bonnington Mills, of Edinburgh, Scotland, report a difference in favor of the disintegrator of £9, or 5½ per cent in the item of the marketable value of flour. As this grain is equivalent to an extra profit of £16 on each 100 quarters of wheat (a sack being 280, and a quarter of 496 lbs.), and the rate of produce being 20 quarters per hour, no inconsiderable gain is effected. The repairs, it is stated, on one of these mills, working 22 hours per day for twelve months, were practically nothing. These mills are coming into extensive use.

THE TEMPERATURE REQUIRED FOR IGNITION.

EVERY BODY knows that combustible substances require varying degrees of heat to ignite them; but, even among the best informed scientists, the knowledge of the amount of heat, or the exact temperature at which such substances will take fire, is very imperfect, for the simple reason of the want of data. Extensive experiments have been made to determine the melting points of solids, the boiling points of liquids, even the temperature of flames and the units of heat produced by the combustion of given quantities of different fuels; but with regard to the temperature required to cause the ignition of different substances, experiments have thus far been few. The late fires, and the resulting controversies about their origin, have now given great importance to this branch of investigation; we have therefore judged it opportune to collect some information upon this subject, taken partly from reliable data of some prominent investigators, and partly from original investigation. We give the following table, commencing with substances combustible at the lowest temperatures, and ending with those least inflammable:

TABLE OF THE TEMPERATURES REQUIRED FOR THE IGNITION OF DIFFERENT COMBUSTIBLE SUBSTANCES.

Name of Substance.	*Temperture of Ignition.* Fah.	*Remarks.*
Phosphorus	140°	Melts at 110°.
Bisulphide of carbon vapor	300°	Boils at 113°.
Fulminating powder	374°	Used in percussion caps.
Fulminate of mercury	392°	According to Leygue and Champion.
Equal parts of chlorate of potash and sulphur	395°	
Sulphur	400°	Melts at 230°; boils at 850°.
Gun-cotton	428°	According to Leygue and Champion.
Nitro-glycerin	494°	" "
Rifle powder	550°	" "
Gunpowder, coarse	563°	" "
Picrate of mercury, lead or iron	565°	" "
Picrate powder for torpedoes	570°	" "
" " muskets	576°	" "
Charcoal, the most inflammable willow, used for gunpowder	580°	According to Pelouse and Fremy.
Charcoal made by distilling wood at 500°	660°	" "
Charcoal made at 600°	700°	" "
Picrate powder for cannon	716°	
Very dry wood (pine)	800°	
" " (oak)	900°	
Charcoal made at 800°	900°	
" " 1800°	1100°	
" " 2400°	1400°	
Aluminum	1832°	
Iron	about 2000°	

The most interesting feature shown in this table is that even the most combustible substances, usually considered very dangerous, will only ignite by heat alone when the

heat reaches a considerable figure, and that, for their prompt ignition, a spark is required, which is in fact a temperature of 900° or 1000° applied to a very minute spot of the mass.

As the heat of superheated steam ranges from 300° to 500°, it is only able to set fire to such substances as sulphur, gun cotton, and nitro-glycerin; it is, perhaps, able to fire gunpowder, but it certainly can not ignite wood. It is only when well-dried wood, sawdust, or rags have been made a source of spontaneous combustion, by the presence of any drying oil or its equivalent, that (by oxidation of this oil, presenting a large surface to the agency of the air,) the temperature may be indefinitely raised, and finally reach 400°, 500° or more degrees, and so the point of inflammability may be attained. This may happen in buildings not heated at all; but it must be acknowledged that the heat of summer, and, still more, the heating of buildings with hot air or otherwise, favors this heat production, which is of a purely chemical nature, and is, oftener than the heating arrangements, the cause of fire.

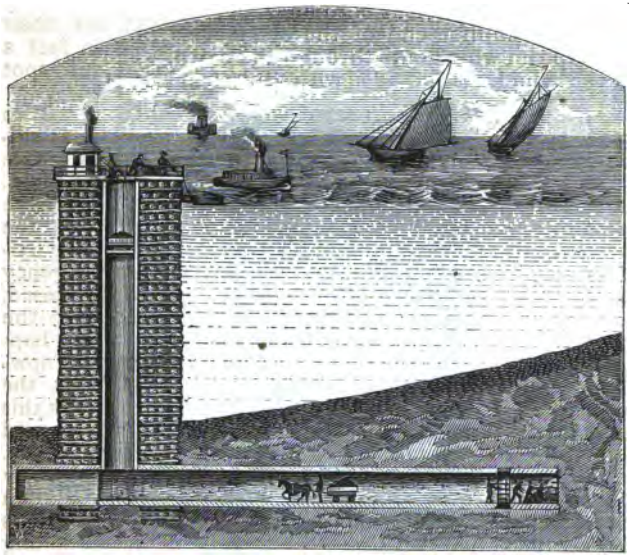
We have stated, on a former occasion, that it is usually very difficult to determine the cause of a fire, as it often destroys all evidence; but it is strange that some minds persist in attributing every fire originating in a building heated by steam to superheated steam; and, in order to give an apparently reasonable explanation, they go even so far as to assert that, during the night, when the fires are banked or even withdrawn, there would be heat enough left in the bricks of the furnace to raise red-hot steam. It is an absurd theory that the result of the fire should have a more powerful effect than the fire itself.

(83)

SCREW PROPELLERS.

In screw vessels, when the propeller quits the water in a seaway, the engine is subjected to violent shocks, the effects of which are dangerous at high speeds. If, however, the horizontal shaft can be driven at a moderate speed, whilst the quick movement is still maintained for the screw, the inconvenience above mentioned would be avoided. M. Trèves, a French officer of marine, has produced a design in the solution of the problem. The horizontal shaft traverses a bevel wheel on the same axis, but independent of the shaft, and fixed. The result is that for one turn of the horizontal shaft two turns of the screw are produced.

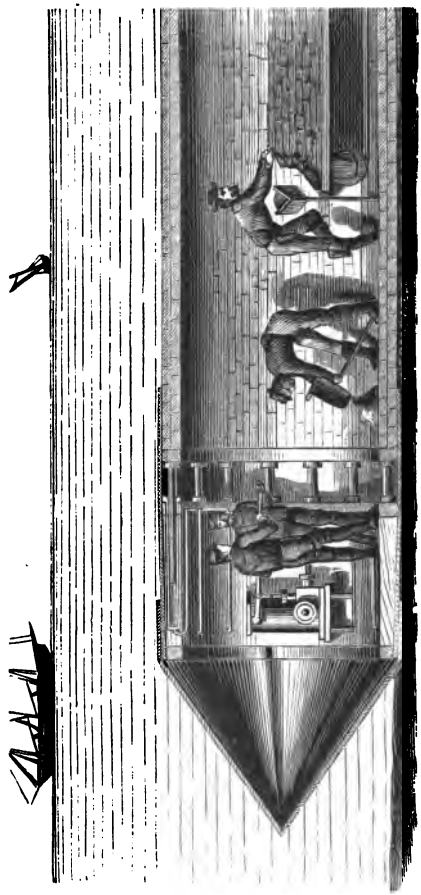
For ocean steamers, the side paddle-wheels have gone out of use. All the Pacific mail steamships are screw vessels.



TUNNELING UNDER LAKE ERIE.

OUR sketch indicates the general method of carrying on the works now in progress at Cleveland, Ohio, for the supply of that city with pure water from Lake Erie. The general plan is the same as at Chicago. Owing to the many oil-refineries and other manufacturing establishments at Cleveland, the water of the river and of the lake near the shore is so contaminated as to be unfit for domestic use. The municipal authorities have accordingly contracted for the construction of water-works, so arranged as to draw water from the bottom of the Lake, at some distance out from the shore, between one and two miles. At the outermost point they have built a crib dock, in the centre of which is a shaft which communicates with a horizontal tunnel under the bed of the lake; this tunnel constitutes the aqueduct through which the water is to find its way to the city, when it will be pumped into reservoirs having the proper altitude for distribution. The aqueduct, built of brick, is six feet in diameter. In digging through the earth the workmen at the heading are carried forward and protected within a shield or boring-machine, the design of Mr. Alfred E. Beach, of the *Scientific American*, New-York. The machine consists of a

large cylinder, open at both ends, like a barrel without heads. The first end of the cylinder is provided with a sharp rim which cuts through the earth. The rear part of the cylinder is provided with a thin band of steel, termed the hood, in which the masonry is built up; also with a series of hydraulic rams or pushers. When a section of brick work has been built up within the hood, a workman moves the handle of a small water-pump which operates the rams or pushers, and they rest against the front end of the brick work, driving the shield ahead. A new section of the tunnel is then built up within the hood, again the pump is worked, and the machine again driven forward. When the machine advances, it pushes right into the earth before it, and loads itself; and the earth, as fast as it accumulates at the front end of the shield, is removed by the workmen in barrows or cars, and raised through the vertical shaft, dumped on board of scows, and towed off to the dumping-grounds. In working through soft or sandy soils, the front end of the shield is provided with shelving to prevent the earth from coming inward too rapidly. In laying tunnels in ditches, on the



bottom under water, the front end of the machine is inclosed by a conical front or bow, as shown in our larger sketch.

In Cincinnati, Ohio, an eight-foot tunnel has been constructed under the streets, for drainage purposes, by means of these boring-machines. A vertical opening or shaft was first made on Sycamore street, near Hunt street, and carried down to the intended bottom grade of the tunnel. Two of the boring-machines were then lowered into the shaft and set at work boring in opposite directions, the tunnel being laid up in brick as fast as the machines advanced, the earth being removed at the shaft. The tunnel extends from Abigail street along Sycamore street to Court street, where it makes a sharp turn into Court street, along which it passes to Broadway. The crown tunnel is some twenty feet below the street surface, and on its route passes under two canals, the Miami canal, and a branch or raceway. This method of boring has peculiar advantages for city uses, as it permits the construction of tunnels beneath the streets of cities without disturbing the surface or the usual travel of vehicles, while the only earth to be handled is a body equal to the exact size of the tunnel.

The Cleveland and Cincinnati boring-machines were constructed and operated substantially on the same plan as the larger machine used in building the Broadway Underground Railway tunnel now existing in this city, and illustrated in the RECORD for 1872.

This tunnel, it will be remembered, extends from the Broadway Bank, at Murray street, passing under Broadway northerly to Warren street, where, on a curve of 50 feet radius, it turns into the Company's passenger station. This railway is worked on the atmospheric plan, and has been in practical operation for some two years. Thousands of passengers have enjoyed the atmospheric ride under Broadway, finding it an agreable and novel method of traveling. In fact, the Broadway Underground Railway is one of the attractive curiosities of the city. By means of a large blowing-engine, a current of air is made to traverse back and forth through the tunnel, and this current, impinging against the ends of the cars, carries them along like a boat before the wind. The car in use is of about the same size as the ordinary street-car, having seats for twenty-two passengers.

The company are applicants before the Legislature for the privilege of enlarging and extending their works, so as to carry passengers from the Battery, under Broadway, to Harlem River, a distance of nine miles. The present working section of railway was built for the purpose

of demonstrating the practicability of placing a railway under Broadway without injury to adjoining property; and in this respect the work is a complete success. It was alleged and generally believed that the foundations of buildings, as well as the water-pipes, gas-pipes, sewers, etc., would all be damaged by such a railway. In answer to this, the company set to work with one of the boring-machines above alluded to, and built a railway tunnel under Broadway, passing below water-pipes, gas-pipes, sewers, and the foundation of some of the heaviest buildings. The thing was done in a few days without disturbing the pavement, with the omnibuses, drays, steam fire-engines, and the whole throng of Broadway travel thundering along directly over the heads of the workmen; and on its sucessful completion all reasonable objections to the construction of a railway under this thoroughfare were removed. In fact, so strongly in favor of its building have leading property-owners become, that they now present themselves as rivals before the Legislature, and ask that the right of construction may be given to them and not to the Transit Company, which has begun the work, and at a heavy outlay of money demonstrated its desire and ability to execute it with success. The Legislature is not likely to do such an act of injustice, and there is reason to believe that the necessary authority to proceed with the work will be shortly granted to the Beach Transit Company.

PRUSSIAN vs. ENGLISH GUNS.

MANY of our readers have, no doubt, noticed in the papers, says the *Engineer*, statements quoted from the *Börsenzeitung*, as to the startling results recently obtained at Berlin with the new 11-inch Krupp gun against iron plates in August last. According to the *Börsenzeitung*, the 11-inch gun, with a success exceeding "all expectations," has driven its shot through a "12-inch solid plate, a wooden backing of 26 inches, and an inch plate or skin," after which it had "a considerable amount of force left in it." We do not hear at what range this took place, which is an important element in the question, but we understand that 100 yards is the one generally adopted, and report says that a charge of about 70 lbs. was employed. We speak, however, subject to correction; we have accepted the facts as represented by our German contemporary, and proceed to give the results obtained here most nearly bearing on the question.

Our own 11-inch gun, about July, 1871, fired four rounds against a structure known as No. 33 target, at Shoebury-

ness, consisting of 8 inches iron, 6 inches wood, 5 inches iron, 6 inches wood, and 1½ inches of skin. The range was 200 yards. Three rounds were fired with charges of 85 lbs., and the last with 75 lbs., of pebble powder—one shell and three shot being used. In every case the projectile completely penetrated the target and passed on, and this being so, we presume we may safely add, in the words of our German friends, that "it had a considerable amount of force left in it." Indeed, in one instance we can speak more definitely, for a deep indentation was made by the shot's point in a plate some distance to the rear and in the line of fire.

We are next informed that the Krupp 10-inch gun is expected to penetrate the same target as the 11-inch. This is, however, only an expectation, based on the assumption of an increase of charge not yet determined, to which is added as a crowning triumph that the 12-inch Krupp is expected to drive its 660 lbs. projectile through plates from 15 inches to 16 inches thick. Our readers will find recorded in the *Engineer* of June 28th the actual effect produced by our 12-inch 35-ton gun against the above-mentioned No. 33 target strengthened by a front plate four inches thick, on June 20th last. We may here state briefly that the projectile, fired with a charge of 110 lbs. of pebble powder, at a range of seventy yards, drove its head and shoulders through 18½ inches of iron and 12 inches of teak. As a shell the effect was less, but the conditions of the question were complicated by the introduction of an air-space.

THE HELL-GATE ROCK TUNNELS.

IN our RECORD for 1872 we gave a number of excellent illustrations of these remarkable works, showing the appearance of the many tunnels under the East River, the machinery employed in drilling, and other particulars. We now present a diagram, scale of 1 to 3000, showing the progress of the work up to January 1st, 1873. The whiter portion shows the various excavations, and the dotted lines show the parts that have yet to be drilled.

A group of detached rough wooden buildings, a few heaps of stone, two or three tall derricks stretching out their giant arms, and here and there a cloud of ascending steam; such is the quiet exterior that marks the site of this great work of modern engineering which is now being carried on at New-York City, under the waters of the East River, opposite the foot of Eighty-ninth street, in that dangerous pass known as Hell-Gate. The removal of these rocks, which have been a danger and a damage

to mariners ever since our country was discovered, will greatly increase the advantages of the port of New-York, shorten the voyage to Europe, and from a narrow, tortuous, and dangerous channel, produce a broad and open stream through which the largest vessels may pass in safety.

Near the extremity of Hallett's Point, on the Long Island side of the East River, is sunk the great shaft, thirty feet deep and one hundred and five feet broad at its widest part. A strongly built coffer-dam, indicated in the map by the black line and the figures near it, protects it from the inroads of the tide, while into its precipitous sides are hewn ten immense caverns, which, radiating at different angles, extend for hundreds of feet under the bed of the river. These again, at about every twenty-five feet of their length, are traversed by seven nearly semi-circular galleries, so that, for want of better illustration, the work reminds one of a giant cobweb honeycombed in the solid rock.

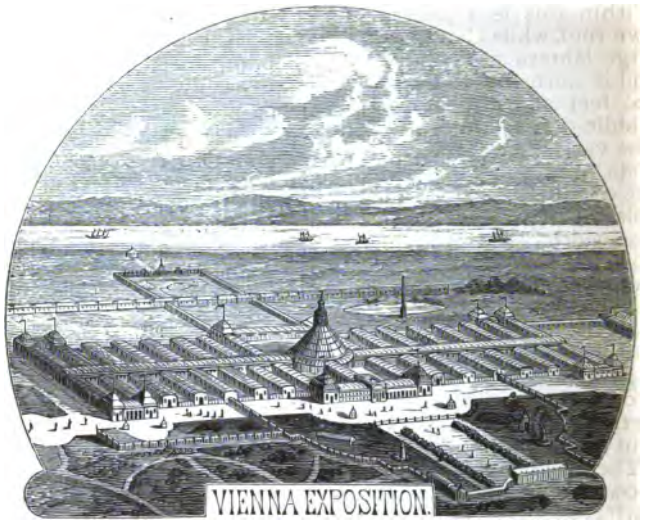
It is proposed to carry the various headings out until they reach a point above which the depth of water at mean low tide is 32 feet; this is the last contour indicated on our map. The next irregular line marks a depth of 28

feet. Seven headings have already reached the proper length: others are being rapidly pushed forward. Grant, or No. 7, heading has now attained a distance of 230 feet. In Farragut, or No. 1, which, when finished, will reach 270 feet, there is yet 70 feet to pierce. The solid piers between the cuttings serve to support the roof of rock, ten feet in thickness, together with its immense super-incumbent weight of water. Altogether, about 4000 feet of excavation have been completed, leaving some 2000 feet more to be done. The average monthly advance is 250 feet.

The bottom of the river is composed of strata of gneiss, through which run veins of quartz. Here and there thin layers of decomposed mica have been encountered, often causing serious leakage, but the rock generally is of great hardness, (as comparatively expressed by geologists, about 6,) rendering rapid boring a matter of much difficulty. The bed slopes away from the shore at a considerable declivity, and as the tunnels are necessarily parallel to the inclination, the drills are often placed to work at angles as great as 45 degrees. Excavations are made in the usual manner by continued boring and blasting, one tool cutting a tunnel just high enough to accomodate the miners, while a second drill, some forty feet in the rear, removes stone from the roof until the gallery or heading has reached its proper height of twelve or fourteen feet. The principal drills used are the Burleigh, and the cost of their use is from 42 to 43 cts. per lineal foot. The average work of this drill is 3½ feet per hour. The drills are worked on the pneumatic principle, that is, by compressed air, which is compressed by steam-power and conducted in pipes down into the various galleries, to the drills at the headings. The works are under the immediate direction of Major-General John Newton.

IN a boiler of fair construction, a pound of coal will convert 9 lbs. of water into steam. Each pound of this steam will represent an amount of energy or capacity for performing work equivalent to 746,666 foot pounds, or, for the whole 9 lbs., 6,720,000 foot pounds. In other words, one pound of coal has done as much work in evaporating 9 lbs. of water into 9 lbs. of steam as would lift 2232 tons 10 feet high.

GUN-COTTON.—To prevent the too sudden explosion of gun-cotton when used in fire-arms, Robert Punshon mixes thirty-three per cent of sugar with it, by first cutting up the cotton in fine particles, and then thoroughly kneading it with the sugar, which has been previously wetted with just sufficient water to dissolve it.



THE GREAT EXPOSITION AT VIENNA.

THE bird's-eye view herewith presented of the vast building erected in Vienna will convey as good an idea of the magnitude and splendor of the World's Fair of 1873 as is possible in so small a space. The site chosen is the Imperial Park or Prater, along one side of which extends the new channel of the Danube, while on the other runs the Danube canal, which separates the Park from the city, so that the Exhibition will lie in convenient propinquity. Great avenues, to permit of ample access and circulation, have been made, the principal of which, the Haupt-Allée, extends in front of the buildings, and through the Park from end to end. The grounds have been beautifully laid out, sheets of water added, buildings removed, and every resource of ornamental architecture and landscape gardening lavished in their decoration.

The central rotunda, with its conical roof, occupies the most prominent position in the view presented. This building will be filled with the choicest objects of the trophy character that the exhibiting nationalities can supply, and will present a *coup d'œil* of surpassing grandeur. It springs from the ground, a circular facade of piers of no less than 426½ feet in diameter, with Roman-Doric columns at either side, and connecting arches filled with glass.

Within this is a gallery 50 feet wide, covered with its own roof, while above rises the great arcaded circuit. The large lantern seen above the roof is 105 feet in diameter, and is surmounted by a second lantern and cupola fully 300 feet above the ground. The rotunda stands in the middle of the grand quadrangle, which is 755 feet square. The vast central gallery or spine is 2985 feet long, and the vista from end to end will probably be as much as even the condition of a Viennese summer atmosphere will enable the unassisted eye to discern objects clearly through. The width of this great hall is 82 feet, and its height from floor to wall-plate 52½ feet. The cross galleries are 250 feet in clear length by 49 feet in width; the open spaces between them will be laid out as gardens, in accordance with the taste and styles of the various nationalities to which they will appertain. The great picture gallery, occupying a position to the southwest of the main building, and quite detached from it, with a length exceeding 700 feet, will probably, while it consists, be the most magnificent fine-art collection in the world.

The machinery annexe is a substantial brick building, shown in our illustration to the rear of and parallel to the central gallery. It is intended to be permanent, and after the Exposition will be used for mercantile purposes. The extreme length is 2614 feet, and the width nearly 155 feet in the clear. The side walls consist of brick piers, running up to the roof, with segment arching between, at a level to suit the side buildings. Ample means of lighting and ventilation are provided. Boiler-houses are constructed at various points along the length of the building, and steam and water introduced from end to end. Down the gangways, at the sides of the central span, are laid lines of rails of the ordinary gauge, so that exhibits can be brought right into the building on the railway trucks, lifted from the latter by traveling cranes, and deposited in their places. Altogether the arrangements of this portion of the Exposition are admirably planned, and the view which will be presented from the gallery—a range of machinery in motion extending for nearly half a mile—will be something which has never been previously witnessed.

Directly on the north-east side of the machinery building will come in the terminus of the North-Austrian Railway, and by proper sidings, etc., with a complete system of turn-tables, immediate connection will be obtained, not only with the rails within the building, but with nine other lines of way, each extending the whole length of the exhibition.

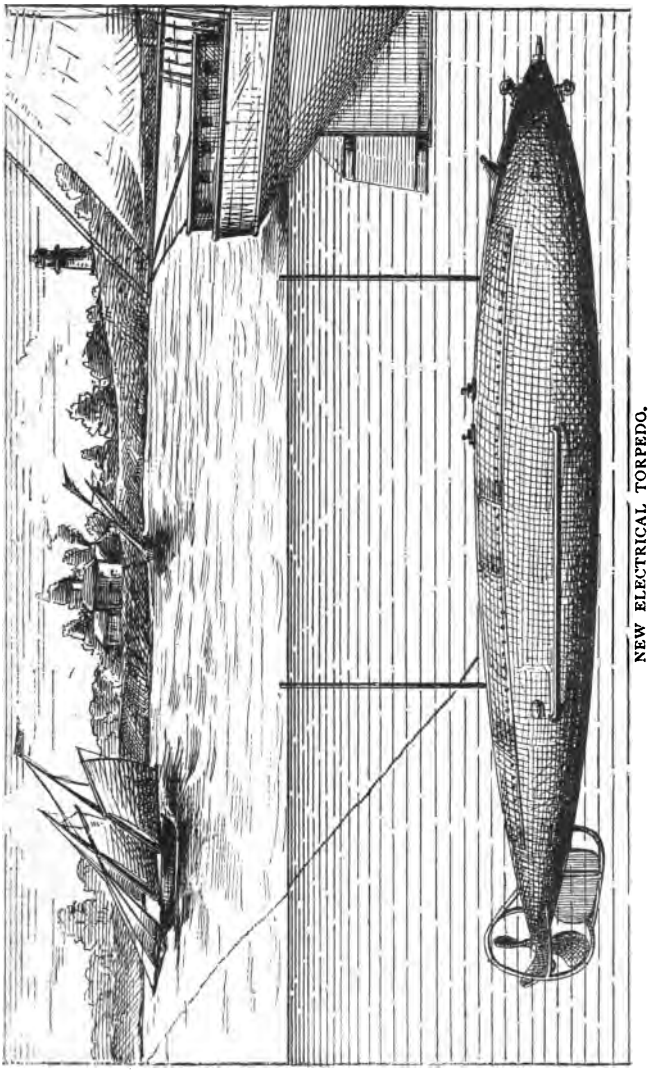
The building faces the southwest. The thirty-two transverse galleries are destined for the reception of the lighter articles of industry, and the assignment of divisions to the different nations corresponds to their geographical situation, the extreme right or eastern division being given to India, and that to the extreme left or west to America. The gallery at the extreme left and front is occupied by the United States, and the gallery directly back of that by South America. In different places about the grounds are small buildings for fire-apparatus, and barracks are erected for the quarters of the troops stationed as guards.

The Exhibition opens May 1st, and closes October 31st, 1873.

Many thousands of visitors from the United States are expected to be present. To pay the expenses of the American exhibitors and assist in making a show from this country, Congress appropriated two hundred thousand dollars in money, provided for the employment of several scientific men, who are to be paid, and authorized the President to appoint one hundred honorary commissioners without pay.

NEW ELECTRICAL TORPEDO.

OUR sketch shows a new apparatus, which seems to be the most formidable yet devised. It has lately been tested before a board of army and navy officers at Newport, R. I. From the report of the performances, we are led to believe that the inventor, Mr. John L. Lay, has accomplished an important step in advance in the science of submarine naval warfare. The hull of the craft is about thirty feet long and three inches wide, cigar-shaped, and formed, water and air-tight, of iron plates. It is divided into three compartments; one for motive power, another for machinery, and the third for electrical apparatus. The motive power consists in carbonic acid gas compressed in sufficient quantity to drive a pair of oscillating engines of eight horse-power, and thus operate the screw for the period of half an hour, during which time the boat is designed to travel some six or eight miles. The machinery is controlled by wires leading to a battery on shore, the opening or closing of the circuit or wire governing the throttle, and the same on the second wire actuating the steering gear. The cable containing the wire is paid out as the boat moves, and, of course, no crew is required on board. The vessel is almost entirely submerged, and, being painted green, is indistinguishable at short distances by the unaided eye.



NEW ELECTRICAL TORPEDO.

In the magazine are placed 500 lbs. of powder or nitroglycerine, and in the forward portion of the vessel explosive shells are also arranged, to be fired by an electric spark passing through a third wire in the cable. The explosion of the shells may be effected without injury to the boat, but that of the magazine necessarily causes her destruction. During the experiment at Newport, a torpedo charged with ten pounds of powder was put in position, and then the boat was started from the shore of Goat Island. It darted off like a harpooned whale, and described a complete circuit of the harbor, going a distance of about two miles. The operator, who remained on shore, had perfect control of the craft, and with his electrical switches moved her to port or starboard, and stopped her at will. Having demonstrated for a considerable time the facility with which she could be propelled and guided, her course was changed to the shore or the point from which she started. Then she was again sent out in the direction of a large row-boat, which had been anchored as an imaginary vessel of an enemy a short distance from the island. The bow of the boat, the point where the torpedo was placed, was directed against the row-boat, and instantaneously there followed the explosion of the projectile. The water was thrown about thirty-five feet or more into the air, and the timbers of the boat were sent flying in all directions. Quite a large number of prominent foreign officers witnessed the tests, and pronounced favorable opinions at their close.

On a subsequent trial the torpedo was sent off to the distance of a mile from the shore, and there operated with perfect facility.

REPEATING TELEGRAPHIC MESSAGES.

To avoid the loss of time caused by repeating messages over the wires, W. C. Barney proposes the utilization of the ground conduction wire for that purpose. He states that by connecting the positive pole of the battery with the transmitting instrument, and interposing a receiver at the sending office between the ground-plate and the battery, that a message sent from one station will pass along the wire to the receiving instrument in the distant station, from that to the ground-plate of that office, along the earth line to the ground-plate of the transmitting office, and thence to its receiver, whereby a message can be repeated to verify its correctness without loss of time on the wire. He also suggests that under certain conditions of the atmosphere, the message may best be sent through the ground line to the receiving office and thence back over the wire to the sending office.

A FAST VELOCIPEDE.

PROFESSOR GEORGE GRANT, of New-Glascow, Nova Scotia, is the author of the singular-looking vehicle shown in our sketch. Queer as it looks, it contains the elements of speed. The large driving-wheel is operated by crank-pulleys, as shown, the steering being done by the passenger's feet. The author states that on smooth ice he has attained a velocity of a mile per minute. On hard smooth roads the vehicle runs with ease, while as to the steerage, it is under perfect control. The device has the merit of simplicity.

IMPROVEMENT IN STEAM-CYLINDERS.

A NEW style of cylinder for steam-engines, introduced by William Corliss, consists in setting within the outer casing a bushing having an interior surface of hard metal, and an outer surface of softer material. The inner surface may be of cast steel hardened and the outer of iron, or the whole bushing may be made of one kind of metal but hardened by any suitable process on the wearing surface. The space between the bushing and the outer casing may be filled with any suitable non-conducting material, or it may be left vacant to form a steam jacket.

THOMAS THOMPSON has obtained a patent for a combined door-plate and letter-box, so arranged that when you pull the door-bell, the letter-box flap opens and the name of the resident of the house appears.

ADJUSTMENT OF SHIPS' COMPASSES.

PROFESSOR E. DUBOIS, of the naval school at Brest, has spent much time in studying the best means of obviating the dangers which arise to ships in consequence of the deviations of their compasses. With this view he has constructed a gyroscopic compass, revolving 8000 times per minute, mounted upon Cardan's triple suspension, and carrying a needle supported above a graduated circle. In accordance with a well-known property of the gyroscope, this circle maintains an invariable position, and indicates the precise number of degrees through which the vessel may be turned to starboard or port, thus furnishing the means of obtaining the true direction of her head at any time after it has once been obtained from observation on a head-land. This instrument may therefore be used to determine all the deviations of the compass on board ship. Some experiments made with it on the corvette *Bougainville*, in the roadstead of Brest, are said to have been extremely satisfactory.

THE UNDERGROUND RAILWAYS IN NEW-YORK.

THE work of depressing the track of the Harlem Railway on 4th Avenue from the Grand Central Depot Forty-second street, to Harlem River, a distance of about five miles, is now vigorously progressing, and is expected to be completed in about two years. Four tracks are to be laid, and nearly the whole width of the avenue will be occupied.

The above road pertains more especially to the Hudson River, Harlem, and New-Haven railway lines. The city still lacks the means for safe and rapid transit from one end of its limits to the other, and the inhabitants are considerably exercised upon the subject.

The State Legislature has authorized the building of roads on various plans and routes, except the best route of all—Broadway. Here the Beach Pneumatic Transit Company have built a short working section of their atmospheric railway, which operates admirably, and have applied to the Legislature for authority to continue their works up and down Broadway, and through the city.

The engineering estimates place the cost of the road at about $1,000,000 per mile. This will be about the cost of any fast city railway, whether on the elevator or bridge plan, or underground. This cost is so heavy that capitalists are unwilling to invest unless the very best route is selected, and the Broadway route is generally concluded to be the best.

Objection has been made to the tunnelling of Broadway for the reason that the adjoining buildings might suffer

damage. But our leading engineers and architects concur in testifying that no such injury could ensue. In fact, Broadway has been already tunneled on both sides, for the greater part of its length. The vaults under the sidewalks adjoining buildings are simply tunnels. Surely no damage could ensue from the placing of similar structures at a distance from buildings, in the centre of the street; and the railway under Broadway will simply be an elongated vault.

In fact, the question was long ago settled in a practical manner by the Beach Transit Company in building their present tunnel, which extends from Warren street down Broadway to Murray, below water-pipes, sewers, gas-pipes, and the foundations of some of the heaviest buildings on the street.

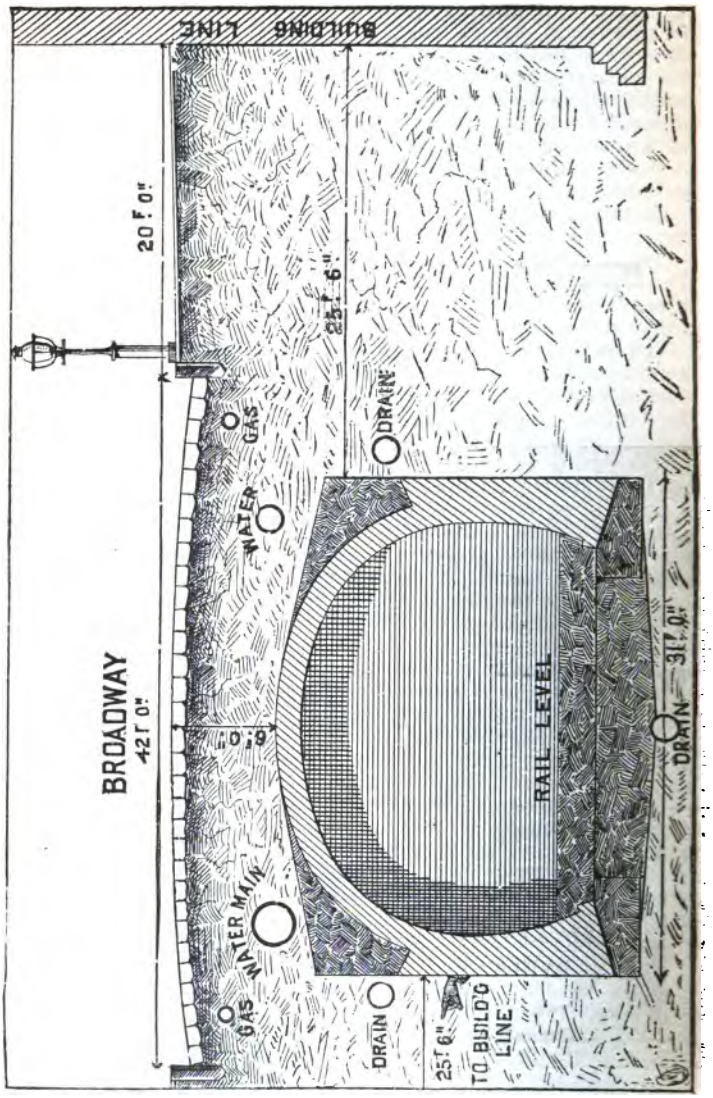
It has also been objected that the depression at Canal street would be a serious obstacle. It is true that here, for a distance of a few hundred feet, the roadway would have to be carried below tide-level. But this can be easily effected, as will be readily understood by a glance at the construction of the London Underground Railway. The section known as the Metropolitan District Railway, a length of 7¼ miles, has 5½ miles of its track built below tide-level. For a distance of 1¼ miles, along and under the embankment, the rails are 13½ feet below the level of the river adjoining. The foundations in some cases were carried down running through sand, salt, and treacherous soil, to a depth of 37½ feet below tide-level.

The foundations of our Brooklyn and New-York Suspension Bridge were carried down through sand and gravel to a depth of between fifty and sixty feet below the surface of the river.

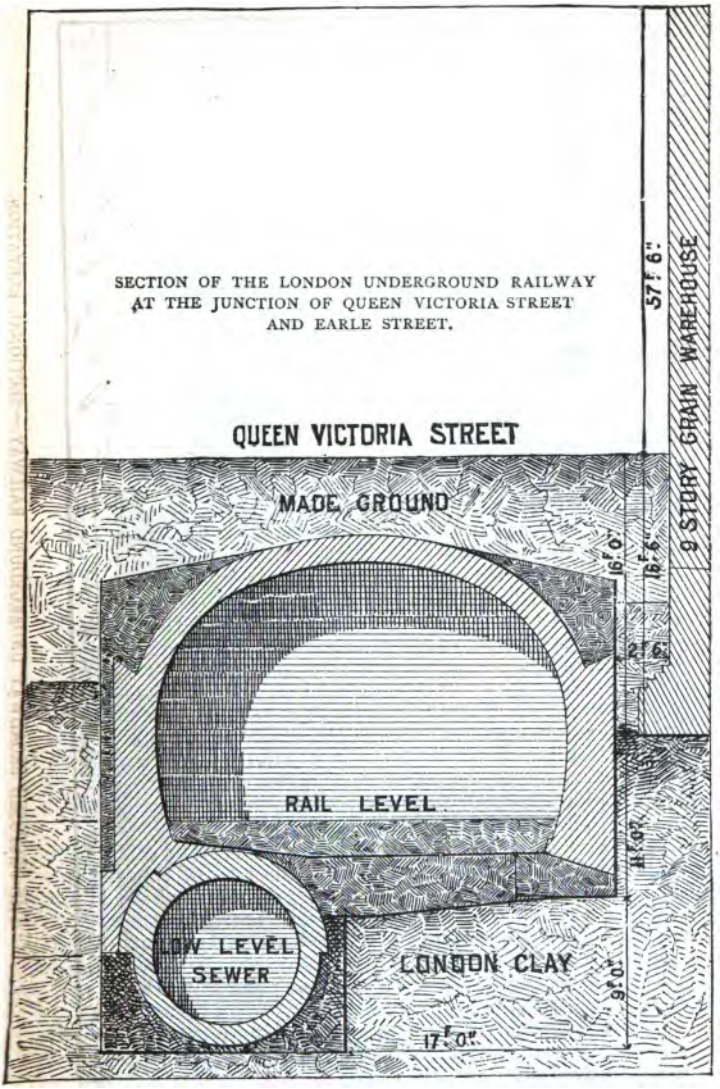
In view of such facts, which are patent to every intelligent engineer, there can be no reasonable objections to the underground railway on Broadway. The vibrations of trains passing over its rails would be far less than those now experienced by the passage of a single omnibus over the surface pavement.

Herewith we give a section of Broadway, with the measurements showing the relative position in respect to the buildings of the tunnels proposed by the Beach Pneumatic Transit Company.

For the purpose of comparison we also present a sectional view from the London Underground Railway, with the measurements, showing the position of the railway in respect to the adjoining buildings on Queen Victoria street at the junction of Earle street. It will be observed that there is an 11-foot sewer below the railway, and that the bed



THE PROPOSED BROADWAY UNDERGROUND RAILWAY.—SECTIONAL ELEVATION.


SECTION OF THE LONDON UNDERGROUND RAILWAY
AT THE JUNCTION OF QUEEN VICTORIA STREET
AND EARLE STREET.
QUEEN VICTORIA STREET
MADE GROUND
RAIL LEVEL
LW LEVEL
SEWER
LONDON CLAY
9 STORY GRAIN WAREHOUSE
57' 6"
16' 0"
16' 6"
21' 6"
11' 9"
9' 0"
17' 0"

of the railway is 11 feet below the foundations of the building on the right, the walls of which are only 2½ feet distant from the side wall of the railway. This is a nine story building, 80 years old, occupied for storing grain. The railway track here is 8 feet below tide-level, and 23 feet below the surface of the street.

About five hundred locomotives and trains pass here daily, and no damage has ensued to the adjacent buildings since the opening of the road in 1865. Many analogous examples might be cited where the London Underground Railway passes below the foundations and in close proximity to the highest and heaviest buildings on some of the principal streets of London, and also passes directly under some of the buildings, of which Southfield Market is an example, the weight of which structure is estimated at one hundred thousand tons.

The London underground road carries between fifty and sixty millions of passengers per annum, a fact which shows how very popular the underground railway has become in London, as it will be here when the Broadway line is completed.

The method of constructing the tunnel on Broadway would be the same as that so successfully adopted in London, to wit: narrow trenches are dug, in which the side walls are built up high enough to receive the arch-centres, upon which the arch is carried over, leaving the solid earth in the middle, which is afterwards removed through the tunnel. In this way only a small portion of the work is under execution at once, while the trenches and short sections of arching are covered by temporary bridges, so that no obstruction of the street travel ever takes place. In the upper part of the city, where rock is encountered, the pneumatic drill, so effectively employed at the Hoosic tunnel, Mass., at Hell-Gate, and other places, would be employed. These drilling appliances are now so perfect that the rocks can be tunnelled with almost the same facility as soils of gravel or clay.

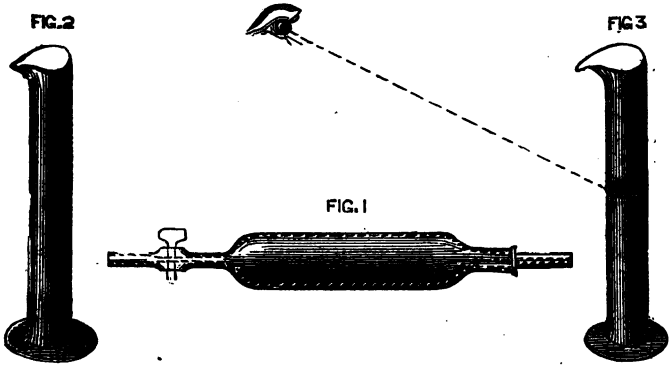
In an engineering point of view, no serious difficulties of any kind would attend the construction of this railway under Broadway. It is the true and rational route for such a work; it is central, and will better accommodate the public than any other; and its construction ought, therefore, to be immediately authorized. The New-York *World* has very justly remarked, in respect to this enterprise: "No scheme of rapid transit to-day presents a better route, a more adequate and practicable plan, or one on which the sentiments and opinions of the people are more fully settled and agreed."

TECHNOLOGY.

TEST FOR AMMONIA IN COAL-GAS.

By William Fiddes, F.C.S., Gas-Works, Bristol.—By this method I have repeatedly made three and four experiments with the same apparatus in the course of an hour, whereas by the old methods it would occupy twenty-four hours to obtain one result.

Preparation of the Test.—Dissolve, in a flask containing a small quantity of hot distilled water, about 400 grains of iodide of potassium. Place the flask on a sand or water bath, and add a strong solution of bichloride of mercury, occasionally shaking the flask until the precipitate which is formed ceases being dissolved. Allow the red precipitate to subside, and decant the clear liquid; add about 1000 grains of caustic potash in strong solution. Make up to a deci-gallon with distilled water, and add a small quantity of bichloride of mercury solution, say 5 septems. Allow to subside, and decant the clear liquor into a stoppered bottle for use.



To Test for the Presence of Ammonia.—Allow a stream of gas to bubble through a vessel containing distilled water. After the gas has been passing a few seconds, add a measure of the test—say 5 septems—and if ammonia be present, a yellow or brown coloration will be produced.

To Estimate the Ammonia.—Run into the washing apparatus (Fig. 1) about 50 septems of acid solution. Con-

nect it with the meter, and pass 1-10th of a cubic foot of gas, measuring the same after its passage through the apparatus. Transfer the acid solution containing the ammonia and the washings from the apparatus to one of the cylinders, (Fig. 2.) Make up to 200 septems with distilled water, and add one measure of the test solution. Observe the color, and to another cylinder run in from the burette as much standard ammonia as you think will produce a corresponding depth of tint. Make up with water until the volumes in both cylinders are equal, and then add one measure of the test. Allow the liquids to stand a few minutes. Place the cylinders upon a piece of white paper before a window, and observe the color, which is best done by looking at the surface of the liquid obliquely, (Fig. 3.) If the coloration in both is of equal intensity, the standard solution taken represents the amount of ammonia present in 1-10th of a cubic foot of the gas. If not, a different amount of standard ammonia must be run into another cylinder, repeating the same until the colors become equal. It frequently happens that two or three such comparative experiments will be found sufficient.

When sulphureted hydrogen is present in the gas to be tested, the acid solution, and washings containing the ammonia, must be boiled some minutes, in order to expel all traces of sulphureted hydrogen before applying the test. (54)

STEARIC AND PALMITIC ACIDS, NEW METHOD.

By Professor J. C. A. Bock, of Copenhagen.—In this process, the albuminous envelopes are broken and partly destroyed by the action, for a limited time, and at a given temperature, of a small quantity of strong sulphuric acid. The neutral fat is then poured out from the envelopes in a state ready for decomposition by water in open tanks, an operation which requires several hours for its complete performance. Its progress is judged of by microscopical examination of the crystals of the fat, or fatty acid, co-formed by slowly cooling a thin layer upon a glass slip. When it is completed, the glycerine, which is dissolved in the water used for the decomposition, is drawn off, purified, and concentrated for sale. The fatty acids, amounting to 94 per cent of the original fat, are at this stage of a very brown or blackish color. The next operation is to eliminate the albuminous envelopes, and with them most of the coloring matters. This is done by submitting the fatty acids in open tanks to the action of dilute solutions of oxidizing agents, by which the black matters are partly oxidized, and their specific

gravity greatly increased, so that when the oxidation has proceeded far enough, they readily subside to the bottom of the tank, leaving the fatty acids comparatively good in color. The oxidizing agents employed are—the three strong mineral acids, sulphuric, nitric, and hydrochloric, permanganate and bichromate of potash, and hypochlorite of lime. After two or three washings with dilute acid and water, the fatty acids are cold pressed and hot pressed in the usual way, and the result is a stearic acid higher in melting-point and greater in quantity than could be produced in any other way, and an oleic acid excellently fitted for the manufacture of soap and other purposes. One of the greatest advantages of the process is, that all operations are conducted in open tanks, boiled with steam not exceeding 35 lbs. pressure.

Mr. W. L. Carpenter, author of the above paper, is at present engaged in England in applying this process to palm-oil and other vegetable fats, and he illustrated his paper with specimens of the various stages of manufacture. (6)

PURIFYING OILY RESIDUUM.

ALONZO FARRAR proposes the purification of the oily residuum left after purifying sulphuric acid that has been used in refining petroleum, by heating it in a boiler by a steam-coil or otherwise to 150° or 174° F., and then forcing through a rose or pipe air or steam into and through the liquid, causing it to be thoroughly permeated by the steam or air for twelve hours, after which the material is again heated so that the oil may be separated by subsidence. By this process the oil is deodorized and rendered fit for painting and other purposes.

PLUMBAGO.

THE value of plumbago, or graphite, depends on its amount of carbon. In order to ascertain this, the simplest and best method is to dry the pulverized graphite at a temperature of some 360° F., and then place it in a tube, 4 to 5 inches long, and half an inch wide, made of hard glass and closed at one end. To this is added about twenty times as much well-dried oxide of lead, and the whole is well mixed. The tube is then first weighed, and afterward heated before the blowpipe till the contents are completely effused and no longer evolve gases. After this operation, which does not last longer than ten minutes, (if the quantity is not too large,) the tube is allowed to cool, and its weight is again ascertained. The loss in weight is carbonic acid, the oxygen of which has been taken from

the lead oxide, while the carbon is all that there was in the plumbago. For every 28 parts of loss, there must have been 12 of carbon. In general, it is sufficient to take from 1 to 2 grms. of plumbago, and from 20 to 40 of oxide of lead.

PHOTO-SIPHON.

CONVENIENT siphon-pipes for draining off nitrate of silver solutions, from bath into bottle, or from bottle into bath, may be made as shown in cut. The short pipe is for access of air; to start the siphon, suck the air with the mouth through the short pipe. The short pipe should only pass through the cork, not down into the liquid. For filtering, attach a filter to one end of the long pipe.

TREATING PHOSPHATES.

MESSRS. PRATT & LEWIS treat the ordinary South-Carolina phosphatic rocks by grinding in a burr-mill and feeding in with the phosphate sufficient dilute sulphuric acid to form a stiff paste, which is then pressed until the phosphoric extract is squeezed out, which may be then evaporated by artificial heat; or driers, such as plaster, lime, sawdust, cotton-seed, or oil-cake, and dried phosphates, or super-phosphates, be mixed therewith. Or, after the extract has been dried, soda-ash, potash, sulphate of soda or ammonia, common salt, or carbonate of magnesia, may be added thereto. Instead of evaporating the extracts, the salts, earths, etc., may be mixed therewith, and the compound calcined or dried.

PURIFYING PARAFFINE.

INSTEAD of melting the paraffine and then subjecting it to the action of benzine, S. W. Crocker proposes to break up the material in small pieces, and then mix with it the benzine, which acts as a solvent and brings the solution to a pasty mass, and then unites with the objectionable coloring matter. When in this condition, a little warm water or milk may be added, or steam may be employed, to raise the temperature to about 80° or 90° Fah., in which state it is kept for about one hour, and then pressed in the usual manner, during which time it is subjected to a warm bath of water and steam.

MANUFACTURE OF PAPER.

In preparing straw, esparto grass, etc., for making paper pulp, the alkali used in its preparation is generally removed by washing, which necessitates the use of great quantities of water and a loss of material. To overcome this, A. E. Reed proposes to neutralize the alkali by first pressing out as much as possible of the alkaline liquor, and then agitating the fibre in a bath of either sulphuric or hydrochloric acid, of about one quart of acid to one hundred and twenty gallons of water. The liquid is then pressed from the pulp and the latter is ready for bleaching in the usual way.

FUSION-POINT OF JAPAN VEGETABLE WAX.

By Dr. C. Roucher.—The wax here alluded to is the product of the *Rhus succedaneum*, and is now a common article of commerce. It is harder than bleached bees-wax, but more readily fusible. The fusing-point is stated to be at from 40° to 42°; but on experimenting with two different samples, the author found that in reality the wax has two different fusion-points, for, on being heated cautiously from 40° to 45°, it does not become liquid, but simply softens, and remains opaque. On being further heated from 45° to 50°, it becomes transparent without becoming quite fluid; at 54°, however, the wax is quite molten. If suddenly heated to above its fusion-point, and, after having been somewhat cooled, it is placed in water at 42°, it again fuses, becoming quite fluid. The fusion-points are therefore 42° and 54°. Japan wax is not a solitary instance of this anomaly, since, according to Duffy, natural stearine (*stearine naturelle*) exhibits three modifications, fusing respectively, α at 51°, β at 63°, and γ at 66°. Bees-wax fuses at from 62·5° to 64°. (14)

NEW METHOD FOR CHROMIC ACID.

By E. Duvillier.—The process consists in the decomposition of chromate of baryta by nitric acid. 100 parts of the chromate of baryta, 100 of water, and 140 of nitric acid (sp. gr. = 1·384) are boiled together for ten minutes; it is essential that the water be first added to the chromate, so as to form with it a kind of thickish magma, to which the nitric acid is next added. After ebullition, there are added 200 parts of water, and then the mixture is again boiled for ten minutes; on cooling, the greater part of the nitrate of baryta is deposited in crystalline state, but, after decantation, a further evaporation is required to eliminate the rest of the nitrate of baryta, which, however, may be got rid of by means of dilute nitric acid,

thus yielding a solution of chromic acid, which crystallizes after evaporation to a small bulk. By this method, very pure chromic acid is obtained, while none is left behind in combination with the baryta.

COMPRESSIBILITY OF LIQUIDS.

BY L. CAILLETET.—Results of a series of experiments:

	Density. (Sp. gr.)	Temperature.	Compressibility.	No. of Atmospheres Pressure.
Distilled water free from air	1·000	8°	0·0000451	705
Sulphide of Carbon	—	8°	0·0000980	607
Alcohol	0·858	9°	0·0000676	174
		9°	0·0000701	305
		11°	0·0000727	680
Petroleum oil	0·865	11°	0·0000828	610
Petroleum essence (benzoline)	0·720	10·5°	0·0000981	630
Sulphuric ether ..	—	10°	0·0001440	630
Sulphurous acid (fluid)	—	14°	0·0003014	606

BITARTRATE OF POTASH.

THIS article is manufactured by G. Bourgade, by first grinding the crude argols and dissolving them in boiling water in a steam-jacketed vessel. Sulphuric acid is then added to precipitate the lime, after which boneblack in muriatic acid, with six times its quantity of water, is added and boiled for twenty minutes, and good American clay is put in, until the coloring matter is turned white. The solution is then crystallized in tanks which are heated by steam, and gradually cooled until the crystals are formed.

ACTION OF WATER AND HEAT, OR OF HEAT ONLY, UPON SUGAR.

E. J. MAUMENE.—200 grms. of sugar and 1000 grms. of water have been kept for some twenty-eight hours at the temperature of boiling water; the optical rotatory power of the sugar has then quite disappeared. Sugar and water have been inclosed in sealed tubes and kept for about thirty days at the temperature of boiling water, with the result that the sugar had become entirely converted into an uncrystallizable compound, probably identical with that which Berzelius and Gelis have obtained by rapidly heating sugar to 160°. By heating sugar for eight days consecutively in sealed tubes in steam of 5 atmospheres pressure, (75 lbs. to the square inch, and 153° C.,) the sugar is converted chiefly into carameline, $C_{12}H_4O_4$. In conclusion, the author states that sugar, while being refined or extracted on a large scale, should never be submitted to a higher temperature than 75°, because below that degree of heat sugar is not perceptibly altered.

PHOSPHORIC ACID.

M. BLANCHARD.—Made at Puteaux, near Paris. In order to obtain phosphoric acid, the superphosphate (prepared from rich native phosphatic minerals) is mixed with water, (1200 kilos. to 1000 kilos. of superphosphate,) and this mixture put into stout linen bags and submitted to strong pressure by the aid of hydraulic presses. The liquid is collected in tanks, and next evaporated and concentrated; what remains in the bags is sold as superphosphate at 10 per cent. The lime is eliminated from the phosphoric acid containing liquor by means of sulphuric acid, sulphate of lime being deposited by the concentration of the phosphoric acid solution.

HYDROFLUORIC ACID.

A. P. S. STUART.—In order to overcome the well-known difficulty of removing from the platinum or leaden vessels the hard, compact, rock-like residue left after the mixture of fluorspar and sulphuric acid is heated for the purpose of evolving hydrofluoric acid, the author recommends to mix with the fluorspar an equal weight of gypsum and the proper quantity of sulphuric acid; the residue left, after the expulsion of the hydrofluoric acid, is then found to be of a pasty nature, and is readily removed by water.

VEGETABLE INK.

EXPERIMENTS are being made to acclimatize in Europe the *Coriaria thymifolia*, or ink-plant of New-Grenada. The juice of this plant, locally termed *chanchi*, is at first of a somewhat reddish color, but becomes intensely black in a few hours. This juice can be used for writing without requiring any further preparations; it corrodes steel pens less than ordinary ink, and has, moreover, the advantage of better resisting chemical agents. When the portion of America named above was under Spanish dominion, all public documents were written with chanchi, which was not removed from paper by sea-water.

ANTHRACENE.

AN improvement in the manufacture of anthracene, suggested by H. J. Fenner and F. Versmann, of London, consists in subjecting coal-tar pitch to progressively increasing temperatures, by heat externally applied. At 400° F., an oil comparatively free from solid hydro-carbons is obtained. Raising the temperature to from 500° to 600°, the oil becomes richer in solid matters, and is found to contain naphthaline in excess, with a small proportion of anthracene. The latter increases as higher

temperatures are employed, until at from 600° to 700° the production of anthracene becomes abundantly in excess. Above these temperatures the anthracene diminishes, and chrysene is chiefly obtained. The process recommended as the best by the authors, is to combine the production of anthracene with the distillation of heavy oils from coal-tar, so as to make one continuous process. For this purpose, the heavy oils are to be distilled from the coal-tar, in the usual way, in wrought-iron stills, with which other stills, capable of withstanding the high heats we have indicated, are to be connected. As soon as the heavy oils have been distilled over, the residuum pitch is, without being allowed to cool, run off into the anthracene stills, and the distillation proceeded with. The anthracene as thus distilled is found to be mixed with a heavy viscid oil, from which it is readily separated by filtration and washing with oils of less specific gravity, or by other modes.

CELLULOSE COMPOUND.

A NEW compound, capable of being applied to many of the uses to which hard rubber is now employed, has been discovered by A. K. Eaton, which consists of fifty-four parts of gelatine, dissolved in water, with which from fifty to one hundred and fifty parts of cellulose is very thoroughly mixed, and then forty-six parts of a solution of tannin is added. Starch may be used in place of cellulose, but a less quantity is required. This compound may be pressed in dies or moulded in any form. It is insoluble, and can be mixed with pigments of any desired color.

DISTILLATION BY COLD.

BY ALFRED HUTCHISON SMEE, F.C.S.—A glass funnel (usually of 8 or 9 inches) is drawn to a point and closed. It is supported in an ordinary stand, and filled with ice. Condensation of the watery vapor of the atmosphere then takes place; the dew collects into drops, which trickle down the outside of the funnel, and at last fall from the point, under which a small receiver is placed to catch them. The total quantity of liquid collected in a given time is measured, and the quantity of ammonia determined by Nessler's test.

By the method of distillation by cold, the author found it possible to distill many substances which are decomposed at a high temperature. Thus, many delicate odors of flowers were distilled by placing the flowers under a bell-glass sufficiently large to cover the funnel containing the ice. The odors were found to be more rapidly and

completely abstracted by placing a dish with a little ether under the bell-glass at the time of distillation.

Experiments were made in a garden, in a bed-room, in hospital wards, in the open country, etc. A few of the numbers obtained are here given by way of example:

Fluid collected in minims.	Ammonia in grains per gallon.	Source.
150	1·9712	Erysipelas.
120	0·1791	Garden.
55	6·8807	Drains.
90	2·1000	Bed-room.
..	2·9568	Stables.
150	0·0985	Victoria Park.

DURABLE CRUCIBLES FOR STEEL.

By Dr. G. Feichtinger.—These crucibles are made with the following mixture: Ground-up and lixiviated porcelain mass, 10 parts; graphite, 10 parts; asbestos, (cut up into threads of some 3 mm. length,) 15 parts; powdered quartz, 3 parts; fire-clay, 22 parts.

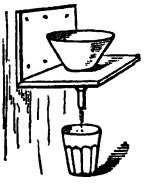
ARTIFICIAL MINERAL WATERS.

A convenient method of manufacturing the various mineral waters—such as Congress, Vichy, Kissingen, etc.,—has been proposed by John Matthews, which consists in finding by analysis the ingredients in a given quantity of any of the waters, and then putting up the required materials, chemically pure, in the form of a tablet or lozenge ready to be dissolved in water as required for use.

THE SUNLIGHT GAS.

This is the name of a novel device applied by R. G. Berford to common gas-burners, and intended to increase the brilliancy of the light by concentrating the rays upon a table or other point below the gas-jet. It consists in placing an open glass bowl below the jet, the bowl being filled with water, which thus forms a powerful water-lens, of large size. This contrivance operates very well at first; but the dust soon accumulates upon the water, falls to the bottom of the bowl, and impedes the light. Except for the trouble of frequently cleaning the bowl, this device might be quite serviceable.

J. G. CRAWFORD suggests a cheap and useful filter-stand, consisting of a couple of pieces of wood nailed together, as shown, one of which is attached to the wall, or other support. A hole through the horizontal board sustains the filter. Neutral chloride of gold is said to be better than bichloride of mercury as an intensifier for negatives. Applied same as the mercury. (9)



AS an improvement in the manufacture of illuminating gas, E. D. McCrocken suggests the introduction of hot air under a pressure, into the retort, the air-pipe being so arranged in the retort as to deliver the air at or near that point where the tar-pipe delivers its tar into the retort. The effect of the air is to assist the vaporization of the tar and its conversion into gas. Other hydro-carbons may be used in lieu of the tar. (9)

SEPARATING SLATE FROM COAL.

BENJAMIN F. DAY proposes to separate mixed ores of differing and specific gravity, such as slate and coal, by passing them down an inclined plane over an aperture through which rises a column of water. The heaviest ore will sink through the aperture, but the lightest will be carried across it by the combined action of the water and its own momentum. The slate or heavy ore falls into a tank containing the water, from which it is carried by an endless chain of buckets, and the coal or lighter ore passes over a screen through which the water passes, to be again forced up through the aperture in the inclined plane by a screw-propeller or pump.

IMPROVEMENT IN MANUFACTURE OF PEAT.

THE advance in the price of coal in England, during the past year, has given a renewed impulse to peat industries, and various plans have been suggested for mining and preparing it for market. One of the great difficulties connected with the peat production is in the grinding and drying operations, which involve considerable manipulation and time. W. S. Tisdale suggests that powdered lime in quantity equal to ten per cent of the weight of the wet peat be fed with the peat into the hopper of the peat machine. The author states that this amount of lime will take up the excess of water in the peat, and do away with the tedious and expensive operation of drying as commonly practised. The peat and lime thus mixed should have a

pasty consistency, so as to be readily formed into suitable blocks. The peat thus treated with lime possesses the quality of mortar, hardens quickly, and becomes quite solid and tenacious. When dry, the peat-blocks will not crumble by handling or transportation. The author further suggests the use of the prepared fuel for the manufacture of iron, in which case a larger quantity of lime is to be added to the peat for the purposes of a flux. (9)

A NEW FUEL has been proposed by Mr. C. L. Fleischman, to be made of grasses or other plants, which are cut before they have perfectly matured, and are then passed while green through compressing rollers, so as to crush and flatten the leaves and stems into a compact mass, which will be cemented together by the juices, and will form, in the opinion of the inventor, a good fuel, and may be also utilized as a building material. It may be mixed with coal-dust, turf, or any resinous, bituminous, or fatty substances, if preferred. (9)

ACTION OF ACIDS AND ALKALIES UPON TEXTILE FABRICS.

BY EMILE KOPP.—Vegetable fibres, (cotton, linen, hemp, etc.,) all having cellulose for a base, resist very energetically the action even of boiling aqueous solutions of the caustic alkalies, but they are strongly attacked by concentrated acids, (sulphuric, nitric, and hydrochloric,) and even by these acids considerably diluted with water, when acted upon by heat. Thus it is possible to immerse a cotton tissue without great injury, in cold water containing in 100 parts 5 to 10 parts of acid; but if the solution is heated, especially if it is boiled, the cotton soon becomes friable, then dissolves, and is transformed successively into gum and sugar. It is to be observed, however, that fuming nitric acid, or a mixture of nitric and sulphuric acids, does not dissolve vegetable fibre, but transforms it, almost without changing its physical aspect, into gun-cotton or pyroxylin. Ammonia is absolutely without action on cotton or hemp, either in the heat or cold; but if a solution is made of hydrated oxide of copper in ammonia, (Schweitzer's blue liquor,) which is a solution of the oxide of cupr. ammonium $[(NH_3)_4Cu,]$ cotton, hemp, and finally linen, are dissolved by it. Vegetable fibres, when pure, have ordinarily little affinity for artificial coloring matters, and are only colored very faintly or not at all by such dyes. A slight application of soap is sufficient to remove the coloration. Cellulose also resists tolerably the action of chlorine and hypo-

chlorites, and has no characteristic odor when burned. Wool, unlike cotton, resists pretty well the action of acid solutions, even when rather strong and warm; but caustic lyes destroy its state of aggregation and dissolve it, particularly when hot. As wool contains sulphur, its solution in caustic soda gives rise to sulphide of sodium which blackens acetate of lead. Nitric acid colors wool an intense yellow; chlorine and the hypochlorites also alter it, giving it a like yellow. Schweitzer's reagent is without action in the cold, but in presence of heat the wool is dissolved. In the decomposition of wool by heat it gives off the characteristic odor of burnt horn. Wool presents a remarkable affinity for coloring materials in general, and especially for artificial colors, which dye it with the greatest facility even without the aid of mordants. Silk gives in burning a similar odor to that of wool. It is dissolved by the strong concentrated acids, particularly when hot. Cold nitric acid colors it yellow. Acids diluted with water have not a very vigorous action. Concentrated alkalies dissolve silk as they do wool, but the solution does not contain sulphide of sodium. The alkalies, much diluted with water, alter, but do not dissolve it; ammonia has no action on it, but Schweitzer's solution liquefies it, as it does cotton. Silk resembles wool in its affinities for coloring matters. (8)

COLORING YARN.

PARTI-COLORED yarn is usually made by dyeing, but H. N. Bruner suggests that it may be printed with lead or other pigments by passing it between fluted rollers covered with the desired color, or by passing it beneath a reciprocating die.

RECOVERING WOOL FROM COTTON AND WOOL RAGS.

SULPHURIC acid and salt have for many years been employed in solution for recovering wool from rag fabrics in which wool and cotton have been laid together, but the process, it is said, greatly injures the wool. J. H. Collins, of Albany, N.Y., finds that the addition of alum entirely prevents such injury. The author uses a solution of sulphuric acid and water of from 6° to 12° Baumé, to which he adds salt up to 9° to 18°. He then adds alum until the hydrometer indicates 10° to 19°. The mixture is then brought up to boiling-heat, the rags inserted and allowed to boil for from four to twelve minutes. They are then rinsed, dried, picked, and carded, the cotton having passed away into the solution. (9)

RECOVERING WOOL FROM RAGS.

EMILE KOPP suggests that the most rational and economical means consists in employing a bath of sulphuric or hydrochloric acid, containing 300 to 500 parts of water to 100 of acid. The rags are left to drain, aired or pressed out a little, and dried slowly, the temperature of the stove or of the current of dry air being gradually raised to 70°, or in certain cases even to 90°. This temperature should be maintained through several hours, and the more as the vegetable fibre is tougher or harder to destroy. If it is wished to really guarantee the wool, it will be well to use a mordant* of alumina, which is made quite simply by adding to 100 parts of an acid bath, 1 to 2 parts of sulphate of alumina of commerce, ($Al_2O_3,3SO_3+18aq.$) or even of ordinary alum.

ISOPURPURIC DYE MATERIALS.

ACCORDING to the recent researches of Dr. E. Kopp, isopurpurate of potassa is best obtained by treating an intimate mixture of picric acid and cyanide of potassium, first with a small quantity of cold water, and after this mixture has been left standing for about half an hour, more water is added and the temperature raised to from 40° to 45°; after cooling, the mass is purified according to Hlasiwetz's process. The best mordants for isopurpurates on silk and wool are mercuric and lead salts; the hue of the colors produced differs from that of those produced from murexide under the same conditions, inasmuch as the isopurpurates yield a magnificent purple with a somewhat brownish orange hue. The color is fast as regards sunlight and sulphurous acid, both of which destroy murexide colors. While murexide-zinc yields a beautiful yellow, isopurpurate of zinc yields deep red, somewhat brownish, hues. Murexide colors do not stand acids and alkalies at all; these reagents render isopurpurate colors somewhat yellow. The alkaline isopurpurates are explosive salts, but the purpurates are not; many reagents decompose these salts entirely, giving rise to the formation of secondary compounds. Isopurpurate of potassa is more advantageously prepared by causing the cyanide of potassium to act upon the picrate of ammonia.

SLATED SCHOOL-BOOKS.—School-books furnished with a slated surface inside the covers are frequently injured by the water used to erase marks, etc. To prevent this, H. B. Barnes has suggested that a water-proof fly-leaf be interposed between the slate and the paper.

* "La mordancer en alumine."

CHAMELEON HAT.

MESSRS. WILKS & DOW have devised a hat having two, three, or more half-rims and crowns, which are united through the median line of the hat, the additional half-brims and crowns being attached so that it or they may be turned over the one or the other half of the hat, thus forming a hat having two, three, or more different styles of outside finish, either of which may be shown at pleasure.

LOOP-PILE LOOMS.

IT has been suggested by J. S. Templeton, that the cloth in the above class of looms be carried, after leaving the "fell," over a narrow bar, down beneath a roller, and up again over another bar in close proximity to the first, between which and the take-up roll the wires are removed, as by this means the latter are retained a long time in the fabric, and the loops thereby improved. On its passage downward, heat may be applied to the back of the fabric by steam-pipes or otherwise. By carrying down the cloth and returning it in this manner, the distance the wires have to be carried back after they are withdrawn is not increased.

TESTING BLEACHING POWDER.

S. CABOT, JR., has found it very convenient, in the determination of chlorine in hypochloride of lime (bleaching powder,) to use an *acid* normal solution of ferrous sulphate, and attach to the bottle, by a copper wire, a rod of zinc, which is immersed in the solution before using it, and reduces the ferric sulphate, that has been formed by the action of the air, to its pristine condition. In this way he believes a normal solution might be used for years. Of course it can be used equally well for the titration of any other oxidizing agent, like permanganate of potash or bichromate of potash.

PRODUCTS FROM MACLURA AURANTIACA.

THE extract of the wood of this tree (a native of Northern Texas, locally known as Bois d'Arc and Osage orange, and cultivated for the purpose of forming hedges) yields with water a decoction used as a yellow dye, while the inspissated aqueous decoction is of such a beautiful yellow color that it might be properly called aurantine. In addition to this coloring matter, the Bois d'Arc contains a large percentage of tannin; experiments made in Texas prove that hides are tanned much quicker with the wood of this tree than with oak-bark. The seeds from

the fruit yield a bland limpid oil, which is used for burning in lamps and also for culinary purposes; this oil resembles olive-oil in taste, and it maintains its fluidity at a low temperature. (17)

ENAMELING CLOTH.

IN the manufacture of enameled cloth and leather, an improvement suggested by L. L. Allen, of Hallowell, Me., consists in an arrangement of rollers, brushes, and enamel fountains, so operating that the leather is drawn into the machine, and the enamel duly applied, and incorporated with its surface, and the prepared leather discharged upon the drying-racks, the whole work being without manual assistance. A very even and beautiful surface is imparted to the goods.

PYRO-GILDING.

BY J. BAYNES THOMPSON.—No method of gilding hitherto in use is applicable to steel or iron; but, for all metals that will amalgamate, no process is superior in result to water-gilding when a gilding thickness only is required, but then the cost is great and the process unhealthy. When a thicker coating is required on amalgamating metal, then the electro process or the pyro process may be used. Good results may be obtained by the electro process if carefully and conscientiously done; but by the pyro process good results must be obtained, for the gold is then put on in successive coatings, and each coating is burnt in before the succeeding coating is put on. By this method, there is no danger of the gold peeling after being finished, for if the process is not thoroughly carried out, it will peel in the furnace long before the heat is raised to 500°.

This method recommends itself more especially for gilding or plating with gold on iron and steel, as there is no other that will accomplish that; and it is superior for other metals, in some points, to any other process, to water-gilding in cheapness and healthiness, and to other methods in results.

The process is this: After the article has been thoroughly cleaned, mechanically and chemically, the first coating of gold is put on, which, to all appearance, is a perfect coating; but when it has passed through the furnace, if the article be of steel or iron, the gold has disappeared into the steel, etc., which appears just slightly tinged with yellow. The next coating, after being burnt in, changes from brilliant gold to a much paler tint; but the third coating comes out of the fire as brilliant as it went in, and this is the test that the gilding is complete.

For gilding, nothing more is required but a good hard burnishing with a steel burnisher to harden and polish the gold; but if, for any special purpose, a thicker coating is required, as many more coatings are put on as are deemed necessary. (3)

SILVER FROM COPPER-PYRITES.

By F. Claudet.—The spent or burnt pyrites (Spanish and Portuguese) contains, according to the author, from 0·0020 to 0·0028 per cent of silver, (equal to from 20 to 28 grms. to the ton,) and, in addition, a small quantity of gold; the extraction of these small quantities might at first sight appear futile, but, as the quantity of pyrites burnt in the United Kingdom alone amounts annually to between 400,000 and 500,000 tons, the extraction of the precious metals therefrom is of importance. The author describes at length a method of operation which is now successfully used in a factory established by him and Mr. J. Phillips at Widnes, near Liverpool; the process is based upon the insolubility of iodide of silver in a solution of chloride of sodium at the ordinary temperature. The burnt pyrites is first ground to powder, sifted, and next gently ignited with some common salt; the ignited mass is, after cooling, treated with dilute hydrochloric acid, and a sufficient quantity of iodide of potassium is added to the clear liquor. In the dry state, the precipitate formed consists, in 100 parts, of—Silver, 5.95; gold, 0·06; lead, 62·28; copper, 0·60; oxide of zinc, 15·46; oxide of iron, 1·50; lime, 1·10; insoluble residue, 1·75; loss and oxygen, 3·62. In the year 1871, at the works above mentioned, 16,300 tons of spent pyrites were operated upon, yielding 333·242 kilos. of silver and 3·172 kilos. of gold, the net value of which, after deducting expense of refining and the loss of 137 kilos. of iodine, was £3230. (4)

TINNING METALS.

E. H. Davis has devised an apparatus for tinning plates and other objects, consisting of a square pot set in a suitable furnace containing the coating or tinning material, provided with a lifting device to raise the plates, etc., out of the bath, and a cover or "temperator" large enough to contain the lifter and its contents. The objects to be tinned are set in the bath and the cover lowered until the air within is heated as near the temperature of the metal as possible. The lifter and its contents are then raised within the "temperator" or co-

ver, and a device attached thereto takes the coated objects from the lifter, allowing the latter to be lowered into the bath ready to receive another set of plates, and the "temperator" and tinned objects are raised and the latter gradually cooled, by which means, it is said, a superior color and appearance is given to the coating. (9)

MOULDING PIPES.

A NEW apparatus for moulding pipes, columns, etc., devised by J. M. Kenworthy, shows an expansible core-pipe made in three or more staves, which fit into collars and are held in place by an internal shaft provided with cones which act on projections inside the staves, so that the core-pipe may either be forced out to its full size, or contracted, to withdraw it from the casting. The moulding device consists of a base, from which rises a vertical plate, the latter being perforated to receive the pattern which projects exactly halfway through it. Flasks are provided which fit the vertical plate and base, and have hoppers on their tops through which the sand is rammed, until the flasks are filled. Two of these flasks, when placed separately against the vertical moulding-plate, and the sand rammed in, form when united a complete mould ready to receive the core.

GOLD FROM IRON PYRITES.

PROF. J. M. MERRICK has, by roasting iron pyrites with marble-dust, then amalgamating with mercury and sodium, succeeded in obtaining metallic gold. He has obtained large returns from specimens of iron pyrites, in which the presence of the precious metal had been denied by the ablest assayers.

PROTECTING THE INTERIOR OF IRON COLUMNS.

THE interior of iron columns, pillars, etc., exposed to the action of damp air, corrode very rapidly, as it is difficult to paint them inside. As a method of preventing such corrosion, Jacob H. Linville coats the internal surfaces with paint, asphalt compound, etc., by closing the end of such articles with caps, and then drilling a hole through which the preserving compound is poured, until the column or pillar is full. The hole is then stopped, and the compound allowed to remain a short time, after which it is run out, leaving a coating over the interior. If corrosion has already commenced, the column may be first filled with dilute acid to clean off the rust.

MERCURY ELEVATOR.

OTTOKAR HOFMAN has devised an apparatus for elevating mercury in amalgamating-machines, in which the material is placed in a closed tank, provided with a vertical pipe, the lower end of which terminates near the bottom of the tank, and the upper end in the top of another tank or an amalgamating-pan. Steam is forced into the lower tank, and the pressure exerted on the top of the mercury causes it to ascend through the vertical pipe to the upper tank or pan, as the case may be.

PLATING SHEET-IRON WITH COPPER.

A. L. FREEMAN has devised a new apparatus for the above purpose, which consists of a pair of feeding-rollers which feed the sheets from the pickle-bath between two revolving polishing brushes, from which the sheets are passed into a tank of water and washed, and from thence into a bath containing the solution for deposition by a battery. The feed-rollers and brushes are so arranged that sheets of different thicknesses may be passed between them, and a tank with drip-pipes is arranged to supply the latter with water for scouring and polishing. The plating-bath is provided with a strainer or false perforated bottom from which the sediment may be withdrawn by a pump, and both the pickling and plating baths are heated by steam-pipes.

TINNING WITH ZINC INSTEAD OF TIN.

C. MENE.—The author calls attention to a fraud which, in France at least, seems to be on the increase, namely, that of using zinc instead of tin for the purpose of lining copper vessels, which are in general use for cooking purposes in France; zinc, being readily acted upon by weak acids, vinegar, etc., yields poisonous compounds. In order to test the tinning, the author recommends the boiling of vinegar in the vessel; if the surface remains bright, genuine tin has been used, but, if the metallic surface becomes tarnished, zinc may be suspected to have been substituted, and further research will be required before using the vessel for cooking purposes.

BRONZING IRON CASTINGS.

GREAT difficulties have been experienced in bronzing large iron castings, owing to the trouble in pickling, etc., caused by their size. To overcome this, Leopold Brandeis proposes that the surfaces be thoroughly scoured and polished by a sand-blast, then plated with

copper by a solution of a copper salt, or by solution and battery, and then coated with zinc or lead. If bronze antique is required, a second deposit of copper is made on the zinc or lead coat, to which is afterward applied a solution of four drams of sal ammonia and one dram of binoxalate of potash in a pound and a half of vinegar, which, it is said, will give the real antique bronze.

COLORING TIN, ZINC, ETC.

JOSEPH KINTZ proposes to color tin, zinc, or similar metals, so as to make them resemble polished brass, by coating the surfaces with copper, and then polishing and lacquering, which will give a permanent color like finished brass work. The polishing may be done before the copper coating is put on, but the effect is not quite so good.

IMPROVEMENT IN THE PRODUCTION OF MALLEABLE IRON CASTINGS.

ONE of the principal difficulties connected with the production of malleable iron castings is the long ovening required—from fifteen to twenty days—in order to impart the requisite malleability to the castings. A. H. Siegfried suggests a much shorter process, which consists in mixing the following compound with the molten iron, before running into the moulds.

The compound is composed of concentrated lye, one pound; sal-soda, one pound; sulphate of copper, one and one half pound; sal-ammoniac, one pound; sulphate of potash, one fourth pound; nitrate of potash, one fourth pound; common salt, three and one fourth pounds; from four to five pounds of this compound to every hundred pounds of iron to be treated. This compound may be mixed with the iron while still in the furnace, or may be mixed with the molten iron after it is drawn from the furnace into the ladle and before it is poured into the moulds. When the former method is adopted, the iron is melted quite thin, and the damper to the furnace is closed, the blast taken off, and the compound put into the iron and the mass worked thoroughly for a few minutes; then the damper is opened and the blast put on and a strong flame created, so as to expel the gases and other impurities. When the compound is put into the ladle, the iron should be stirred freely, so that a thorough mixture may take place. The metal having been run into the moulds, the casting is to be removed while it is at a low cherry-red heat and plunged in a bath or pickle composed of the following ingredients: Water, one gallon; concentrated lye,

one ounce; sulphate of copper, one ounce; alum, one ounce; sal-soda, one ounce; sal-ammoniac, one ounce; common salt, eight ounces; sulphate of potash, half ounce. The casting, when cooled, is removed from the bath and annealed in the ordinary manner for from three to eight hours. (9)

GRAINING WOOD.

J. R. CROSS imitates the natural grain-marks of wood by charging with the appropriate color a plain board of the kind of wood to be imitated, and then wiping off the surplus color, leaving the grain-marks filled, as in plate-engraving. Over this board a clean elastic roller (similar to a printer's roller, but more flexible) is passed, and the color left in the grain-marks is taken up, and any object to which this roller is applied will take the grain-marks from it. The roller may be applied directly to the object by hand, or it may be set in a machine so arranged that the roller and board shall always "register." If preferred, the roller may deliver its color to transfer-paper, which is then applied in the usual manner. (9)

IMPROVEMENT IN PANELS FOR CARRIAGES.

FOR the backs of carriages, and for other purposes, wide panels of wood are required; but the increasing scarcity of large timber has caused a great advance in the price of wide boards. An improved method of producing wide panels consists in placing the tree-trunk in a suitable sawing-machine and sawing it spirally, with a narrow saw, in the direction of its length, from circumference to centre. The wood then has the form of a single sheet, closely rolled up, and may be opened out into one broad panel, perfect in every respect. In this way wide panels from comparatively small timber are produced. For carriage-makers, whitewood is chiefly used for the purposes indicated. (9)

PROTECTION OF WOOD FROM FIRE.

BY F. SIEBURGER.—After first referring to the inconveniences of the application of chloride of zinc and so-called water-glass solution, the author says that it is preferable to first coat or wash the wood twice with a hot and saturated solution of 3 parts of alum and 1 part of sulphate of iron, and next with a more dilute solution of sulphate of iron, to which sufficient pipe-clay has been added to render it as thick as ordinary oil paint. Another method is the following: The wood is repeatedly painted over with a hot solution of glue, until a very thin coat of glue remains on the surface; then the wood is painted over

with a thicker solution of glue, and a mixture of 1 part of sulphur, 1 part of ochre or pipe-clay, and 6 parts of sulphate of iron, is applied to the wood with a dredger, the ingredients having been first separately pulverized and thoroughly mixed. (5)

WATER-PROOF PAPER PANELS.

By W. P. Arnold.—The paper pulp is made in the usual manner and run off in the ordinary way upon a wet-roll paper-machine, the water-proofing or other adhesive material being applied to the paper web as it is passing around the wet roll. A film of the water-proofing material is applied between each layer of the paper web, and thus produces sheets or panels of paper, of any desired thickness, having the interfused water-proofing material thoroughly incorporated therewith, and rendered firm and impervious to moisture throughout. (9)

THE USE OF DIAMONDS FOR STONE-SAWS.

The idea of making use of the extraordinary cutting qualities of these gems in the production of stone-saws has been carried out practically during the past year by H. & J. L. Youngs, of New-York City. At the exhibition of the American Institute in New-York, several of these saws were worked with the greatest success. In general appearance and movement they resemble the ordinary stone-saws; but the edges of the blades are provided, at intervals, with small movable teeth, in which the diamonds are set. The diamond-saw, it is claimed, is applicable to the sawing of all kinds of rock, including freestone, limestone, marble, slate, bluestone, and granite. It is especially valuable on the harder and more difficult kinds. Its speed of cutting is from ten to thirty times faster than by the best machinery heretofore in use for this purpose. It makes as narrow or narrower kerf, a better average quality of work, and saws as thin stuff.

It saves two thirds of the labor bill for sawing and handling, three fourths of the room and one third of the power.

The cost for diamonds and setting is less than for the sand and iron required to do the same quantity of work by the old method; and in sawing, marble will be wholly covered by the value of the marble-dust obtained pure by this method, but entirely lost by the other.

On granite and other rocks too hard to be practicable to sand-sawing, and in a wide range of work now done exclusively by hand, the economies are still greater.

The invention is now in constant use on the largest

scale, that is, with a machine capable of sawing blocks 14 ft. long by 6 ft. 6 in. high, by 4 ft. 6 in. wide, with complete freedom from practicable drawbacks.

No special skill is required for setting the diamonds.

The invention is embodied in machines of two distinct types, viz. the "Rip Saw," or single-blade machine, and the "Gang Saw," for any required number of blades.

The essential feature of the improvement is that the diamonds cut one way only. Without this provision the debris is carried backward and forward in the cut, choking the blade, wearing away the setting of the diamonds and hindering them from getting down properly to their work. Notwithstanding the extraordinary economies of working by these machines, it is said that the entire plant of an establishment using them, including the necessary engine, boiler, shafting, belting and buildings, will cost less than for the same productive power by the best sand-saws.

HARDENING AND WATER-PROOFING ARTIFICIAL STONE.

MESSRS. F. AND E. L. RANSOME, of artificial stone fame, and Henry Bessemer, of Bessemer steel notoriety, are the conjoint authors of a new and important improvement in the manufacture of moulded artificial stone. Composed of sand and soluble silicate of soda, or other material, which is to be cast in a mould of the proper configuration, from the bottom of which mould a pipe leads to an air-pump, so that the air contained in the pores of the artificial stone may be exhausted. A solution of chloride of calcium is placed upon the outside of the stone, which by the exhaustion of the air is drawn into the pores and substance of the stone, thereby hardening and solidifying the same, rendering it impervious to water. The same process may be used for the injection of earthenware pipes, hollow-ware, and other articles, with water-proofing substances. Earthenware pipes are covered with dissolved or heated asphaltum or bitumen, and the air then exhausted; the bitumen is thus driven into the pores, and the pipe rendered perfectly water proof. (9)

HARDENING ARTIFICIAL STONES.

IT has been suggested by J. L. Rowland that artificial stone, béton, concrete, or cement structures, or mortar in or on walls, may be hardened by applying water, steam, or vapors charged or saturated with carbonic acid gas, or carbonic acid dissolved in water alone, or in water containing mineral salts in solution—as silicate, carbonates, chlorides, or sulphates—to the surfaces of such structure,

through a hose provided with a nozzle that will scatter the hardening material in the form of a fine spay. A covering may then be placed over the surface of the object to retard the evaporation of the water or vapor, and to prevent, as far as possible, the escape of the gas.

NEW ARTIFICIAL STONE.

E. WESTERMAYR, of St. Louis, Mo., suggests the manufacture of artificial stone from a composition consisting of cement, gravel, sand, iron slag, and soapstone, reduced to the consistency of mortar by adding water in which borax has been dissolved. The sand is previously cleaned by subjecting it to a bath of potash-water. (9)

ORNAMENTING EARTHENWARE.

C. L. FLEISCHMAN proposes to ornament earthenware by printing or painting upon glue-coated paper a mixture of vitreous material and glue, paste, gum, or oil, in any desired pattern, dusting over it while wet the same vitreous substance finely powdered, which will adhere to the pattern and form a raised surface. The paper so prepared is placed in a mould, and the figure completely covered with pulverized clay. The mould is then filled with cement or coarser clay and its contents submitted to great pressure to fill the spaces between the pattern. The dampness of the clay softens the glue on the paper and makes it adhere to the fabric, keeping the ornamentation in its place. The object is then burnt in the usual manner, as the paper if left on will do no harm, but it may be removed if desired before burning. (9)

FRENCH PUTTY.

BY RUBAN.—7 pounds of linseed-oil are boiled with 4 pounds of brown umber for about two hours; 62 grms. of chips of wax are then added to the oil. After having been removed from the fire, a mixture of 5½ pounds of chalk and 11 pounds of dry white-lead is added to the oil. This putty is stated to be very durable, and to adhere strongly to wood which has not been painted.

FREEZING OF WATER.

BY PROFESSOR BOUSSINGAULT.—The author records the results of a series of experiments, which fully prove that, if the resistance of the sides of the vessel (wherein water is exposed to great cold, the vessel being hermetically sealed) is greater than the expansive force of the act of congelation of the water, the latter remains liquid even at the lowest temperatures to which it is exposed.

POLISHING COMPOUND.

EMERSON'S compound for polishing and cleaning glass, silver-plate, tinware, and surfaces that permit only slight friction and but little action, consists of water four ounces, carbonate of ammonia one ounce. When dissolved add sixteen ounces of Paris white, with aniline for coloring. This forms a solid. As the Paris white consists of white lead, all who purchase this compound should beware of using it upon the inside of culinary vessels.

NEW METHOD OF PRINTING.

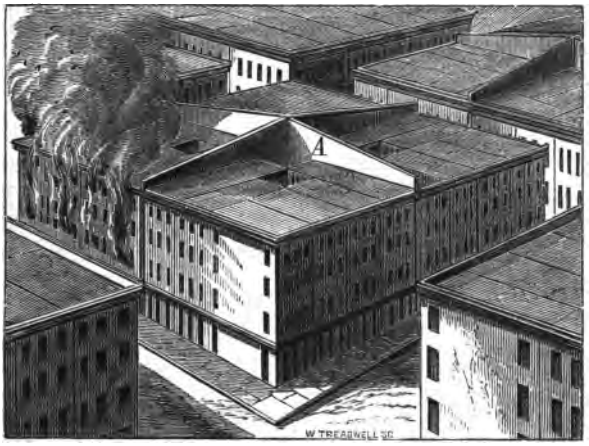
BY E. VIAL.—The author describes a process of printing upon woven tissues, by first impregnating the same with a solution of nitrate of silver, or of any other metallic salt which, on being brought into contact with either metallic zinc or copper, is so decomposed as to set the metal free, and next printing on the tissue so treated a pattern by means of zinc or copper plates; the result being that, wherever contact between the metal and tissue (treated as just mentioned) takes place, there is formed a precipitate of the metal, (silver, in case the woven fabric were impregnated with nitrate of silver,) which is at once indelibly fixed to the cloth, presenting, according to the strength of the silver solution employed, a color varying from a bright gray to an intense black. The color is exceedingly fast, resisting the action of alkalies, acids, and soap. Common printing-types when pressed upon paper or fabric wetted with nitrate of silver, leave a black, indelible impression. (4)

NEW LIFE-PRESERVER.

A NEW life-preserver has been proposed by C. S. Merriman, consisting of a rubber dress made in two parts, divided at the waist, the lower portion having a rigid band or hoop, over which the upper portion is secured by a band and buckle in such a manner as to be water-tight. The head is covered by a cap, made in one piece with the jacket, which is sufficiently elastic to protect the back of the head from water, and yet allow of the face being exposed through an aperture in front. That portion of the dress covering the back of the head and the back and front of the body and thighs is double, so as to form air-chambers around those parts, which may be inflated by tubes that are made long enough to allow of the wearer expanding each chamber without assistance from others.

PROTECTION FROM FIRE.

AMONG the many plans suggested in view of the conflagrations of Chicago and Boston, for the protection of cities from the spread of fires, is one by Wm. H. Vesey, professional accountant, 150 Broadway, New-York. It consists



in the erection of high walls of brick masonry, rising above the buildings, as shown in the engraving, so as to divide and isolate each block of buildings into four parts. This is certainly an effective method, as it would be very difficult for any conflagration to pass such masonry barriers as are here proposed, which in all cases are to be carried higher than any of the adjoining buildings.

TO CUT AND BORE INDIA-RUBBER.

DIP the knife, or cork-borer, in solution of caustic potash or soda. The strength is of very little consequence, but it should not be weaker than the ordinary reagent solution. Alcohol is generally recommended, and it works well until it evaporates, which is generally long before the cork is cut or bored through, and more has to be applied; water acts just as well as alcohol, and lasts longer. When, however, a tolerably sharp knife is moistened with soda-lye, it goes through india-rubber quite as easily as through common cork; and the same may be said of a cork-borer, of whatever size. In order to finish the hole without the usual contraction of its diameter, the stopper should be held firmly against a flat surface of common cork till the borer passes into the latter.

MANUFACTURE OF SALT.

IN the manufacture of salt from the brine of saline wells, air is forced through it to remove some of the impurities. To equalize the currents of air, and to provide a draught to carry off the steam arising from the brine, are the objects of an invention of L. R. Cornell, who arranges a series of connecting-pipes in the form of a gridiron in a brine-tank, through which air, heated to 250° Fah., or more, is forced by a blower. The tank has a conical cover, terminating in a flue, near which is the open end of a vertical air-pipe, the current from which serves to create a draught and carry off the vapors.

MACHINE-MADE SHOES.

GEORGE A. RICHARDSON proposes to unite the uppers to the soles of shoes on a sewing-machine in the following manner: The vamp and quarter are stitched at one side, leaving the other seam open. The sole is then placed on the table of a sewing-machine with the inside uppermost, and the upper has one side of the open seam set in its proper place, at which point the sewing is commenced and continued until the two are united. The open seam is then sewed and the shoe is finished without the necessity of turning, which is required in shoes of this class made in the ordinary way.

TREATING SUGAR.

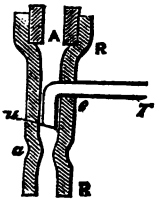
F. C. DURANT suggests the treating of sugar while in the centrifugal machine with an impelled current of air, gas, or other elastic fluid, whereby the separation of the syrup from the sugar is much facilitated. The air to be used is compressed into a reservoir and passes from thence through a nozzle which terminates in a hose connected with a water-tank. The air as it passes through the hose takes with it water from the tank and drives it with great force from a rosehead, thoroughly washing the sugar in the machine. The air may be used alone or its place supplied by steam.

CHALK-LINE HOLDER.

A CHALK-LINE HOLDER, devised by Nathaniel Robbins, consists of a tube filled with powdered chalk and threaded at both ends to receive caps containing cork or other elastic substance. A hole is bored centrally through the caps and corks, and through this the line is drawn, causing the powdered chalk to adhere to it. The cork packing prevents waste of the powder, and the tube serves as a spool to wind up the cord.

IMPROVED WATER AIR-PUMP.

HERR C. CHRISTIANSEN suggests, in *Poggendorff's Annalen*, a very simple method of arranging a Bunsen pump for use in filtration, etc., in the laboratory. The accompanying figure illustrates the suggested modification. R R is a thick walled caoutchouc tube, and is firmly attached about the water-pipe A. With a red-hot needle an opening is pierced through R R at *e*, and into this the bent glass tube *r* is passed. If the water is now allowed to flow through A, but little suction is exerted at *r*; a mercury column attached, as is usual in other forms of the water air-pump, shows an elevation of not more than 1°. If, however, the tube R R is pressed together, as at *a*, the quicksilver rises at once to 26°-27°; a proof that by this device an almost complete vacuum can be obtained. To obtain the result, much depends upon narrowing the tube at the best proper place, for the great increase in effect manifests itself only when this is done at a few points. It is, however, only necessary to experiment until the desired conditions are produced, and then to permanently narrow at the proper point. (9)



BLEACHING CANE-JUICE.

AN apparatus for the above purpose has been devised by Benjamin R. Hawley, which consists in a series of inclined planes formed of frames covered with cloth, down which the juices run, meeting the gas as the latter rises up through the frame containing the planes. The frame is provided with a series of sections similar to drawers in a bureau, and arranged in the same way, but without bottoms, and in these sections the inclined planes are arranged in pairs so that either pair may be removed from the frame for cleansing without stopping the process of bleaching. The frame is arranged over the boiler so that the juice may be partially heated by the gas and hot air.

TORPEDOES FOR OIL WELLS.—As a convenient method of "tamping" torpedoes, John F. Hervey suggests the attachment of elastic cups or sacks of leather or any suitable material, which are to be filled with sand—the cups or sacks being of such size as will allow the pressure of the sand to bear against the sides of the well, and thus securely tamp the torpedoes.

CARBOLIC ACID.

THE value of carbolic acid as an antiseptic is generally admitted. There may be good reasons for doubting its efficacy in destroying the active virus of malignant contagious diseases, but there is no question of its power to retard, or even arrest, decomposition of organic substances, and it is equally certain that it destroys all the lower forms of animal and plant-life. These properties have caused the agent to be highly estimated as a remedy for parasitic diseases, and a powerful deodorizer. Its claims as a disinfectant rest chiefly on the facts of its antiseptic qualities and its influence over living beings which are low in the scale of organization. In this respect, however, it is not in worse position than most of the so-called disinfectants. It is necessary, in testing the action of this agent, to beware of the circumstance that the majority of compounds which are sold as carbolic acid do not contain more than a small percentage of the acid, and some of them are absolutely free from any trace of it. All varieties of light tar-oil are sold for carbolic acid, and some of these preparations, however pungent they may be, are entirely worthless for the purposes for which the acid is most effectual. Again, there are mixtures of light tar-oil with kresylic and carbolic acids containing various proportions of the acids, and quite unreliable on account of the impossibility of finding out by any ordinary and practicable means the quantity of active agents in each sample.

Much mischief has been occasioned by the use of insoluble tar-oils in the place of soluble acid. The insoluble oil floats on the top of the water which is used to dilute it, and the first animal which may be dressed with it receives the greater part of the irritating material on its body, unmodified by dilution; cases of death among sheep and dogs from this cause have been so numerous as to cast on the true acid an amount of discredit which it does not deserve. If the name "carbolic acid" was confined, as it should be, to the pure substance, which crystallizes in fine long needles of a brilliant blue-white color, and the other tar products were distinguished by proper titles, the errors which are now common could not occur.

Coal-tar contains a variety of products which are obtained by distillation—oils light and heavy, ammonia, aniline, picoline, etc.; and also several acids, acetic acid in small quantity, phenic or carbolic acid, kresylic acid or terebane, besides many neutral substances.

Phenic or carbolic acid is obtained by treating the distillate of coal-tar with a hot solution of caustic potash, then adding powdered potassic hydrate, which causes an im-

mediate precipitation of white crystals. The crystallized acid dissolves in about thirty parts of water, and in all proportions of alcohol and ether. In alkaline solutions it forms an emulsion. At a moderate temperature the crystals fuse, and the acid may be caused to remain in the fluid state by the addition of a little water. In contact with the air it becomes darker in color, and sometimes assumes a bright magenta tint.

Pure carbolic acid is seldom used in large quantity, owing to its expense. As a caustic it is very useful, and also as an antiseptic dressing for wounds; for this purpose a solution of one to two per cent is sufficiently potent. No other than the crystalline acid should ever be employed for caustic and antiseptic dressings.

Fluid carbolic acid, as it is generally termed, is usually a mixture, more or less impure, of carbolic acid and light tar-oil with kresylic acid, which is called terebane—an agent that is also obtained by distillation of coal-tar. It possesses the general properties of carbolic acid, but does not crystallize. When fresh, it is nearly colorless; but in contact with wood, or after being exposed to the air, it becomes dark brown and sometimes almost black in color.

Terebane or kresylic acid may conveniently take the place of carbolic acid in veterinary pharmacy. It possesses all or nearly all the advantages of the pure carbolic acid, and is very much cheaper. In order to obtain it of uniform strength, it is necessary to order it of the manufacturers, or otherwise to get it from a chemist who has obtained it under its proper name from the maker's laboratory.

A mixture of one part of terebane with fifty parts of water forms an ordinary application for mange and other skin diseases which are associated with the presence of animal or vegetable parasites; the addition of a little soda to the water, by rendering it alkaline, much improves its solvent powers.

Both carbolic acid and kresylic acid dissolve in glycerine in all proportions, and solutions of any degree of potency may be made by using this solvent instead of water; but the chief point at starting is to determine whether carbolic acid or terebane is to be used—a question mainly of cost—and then to obtain one or the other from the manufacturers direct, or through a respectable chemist. (45.)

PIANO-FORTES.—As an economy in the manufacture of pianos, S. P. Brooks proposes to dispense with the usual sounding-board, by forming the case so that it will answer for both.

CARBONATE OF SODA.

IN the manufacture of this article, James Young places salt and water in an air-tight vessel, and then adds to it a solution of ammonia, (or ammonia may be distilled from a separate vessel, and passed through a pipe into the salt and water,) and a stream of carbonic acid is sent through a pipe into it, either simultaneously with the ammonia, or after, which produces bi-carbonate of soda, and a solution of muriate of ammonia. The latter is run off into an ammonia-still to be used to produce ammonia for a repetition of the operation, and the bi-carbonate may be washed with water to remove adhering or mixed muriate of ammonia, and then boiled with water, or steam may be blown into it, to drive off carbonic acid and residual compounds of ammonia. These compounds of ammonia are used in the production of another quantity of bi-carbonate of soda, while the carbonate of soda already formed remains in the vessel. The vessels in which these operations are performed are air-tight cylinders, revolving on trunnions, through which the pipes referred to above enter. The cylinders are revolved so as to always present fresh surfaces of salt and water to the action of the ammonia and acid, and have furnaces beneath them to heat the contents when necessary.

THE VALUE OF COCHINEAL.

BY DR. CRACE CALVERT.—It is often advisable before buying cochineal to determine its tinctorial power. This may be ascertained by two or three methods. In the first, equal weights of the cochineal to be assayed, and one of known value, are treated with alcohol or a solution of alum. The solutions thus obtained are poured into tubes and placed into a colorimeter. This is an oblong box, which has two apertures at each end and two on the top, in a direct line with the end apertures. The tubes are placed through the opening on the top, and on looking through the end apertures, any difference in intensity of color between the two liquids can be observed. If a difference is detected, alcohol or water is added to the stronger liquor until there is perfect uniformity of tint. According to the amount of dilution required is the relative value of the cochineals.

A good process was published by the late Dr. Penny, of Glasgow. It consists in exhausting a gramme of cochineal with fifty grammes of potash solution, and this extract is further diluted with one hundred grammes of water. The solution thus obtained is mixed with gradu-

ated solution of ferrocyanide of potassium (one gramme of salt to 200 grammes of water) till its color changes to a dark brown. A solution of bleaching-powder of known strength can also be used for the same purpose. The best method consists in dyeing equal surfaces of flannel in a bath composed as follows:

For Scarlet Tints.		*For Crimson Tints.*	
Water	1250 grams.	Water	1250 grams.
Cream of tartar	2 "	Cream of tartar	0.75 "
Tin composition	2 "	Alum	1.60 "
Cochineal	1 "	Cochineal	"

The pieces are then washed and dried, and by a comparison of the relative intensity of shade, the value of cochineal is determined. (65)

MOTOR FOR SEWING-MACHINES,

W. A. GREENLEAF has devised a convenient arrangement of a turbine water-wheel for driving sewing-machines and other light machinery, consisting of a casing, inside which the turbine runs, having suitable inlet and exhaust pipes, the former being connected with the water-supply of the house or provided with water in any other convenient manner. A spring-valve is set in the inlet-pipe, so arranged that the pressure of the operator's foot upon a lever will open it and start the machine in operation. By means of a small turbine, not larger than a coffee-cup, sewing-machines may be readily operated.

ORNAMENTAL LANTERN.

A VERY pretty little lantern, suitable for ornamenting Christmas-trees or for illuminations, invented by Joseph Headford, consists of a sheet of gelatine, colored to suit, united at its ends and to a bottom of metal or other suitable material, in the form of an open cylinder, and provided at its top with a bail by which it may be hung to a tree. The bottom has a layer of wax, tallow, or stearine, through which projects the wick.

CASTING CHILLED PINIONS.

F. R. WHEELDON suggests the following method of casting pinions in chills for the purpose of obtaining a hard surface for the teeth. The annexed sketches, Figs. 1 and 2, show a mould with the chills *a a* inserted, and suitable for a pinion of a mill for rolling wire or hoop iron. Fig. 3 shows the mode of inserting the chills adopted by Mr. Wheeldon in the case of moulds for larger pinions or wheels. When pinions are shrouded at each end, the

insertion of the chills would, if no means were adopted to prevent it, interfere with the longitudinal contraction of the casting and render the teeth liable to be stripped from

FIG. 1.

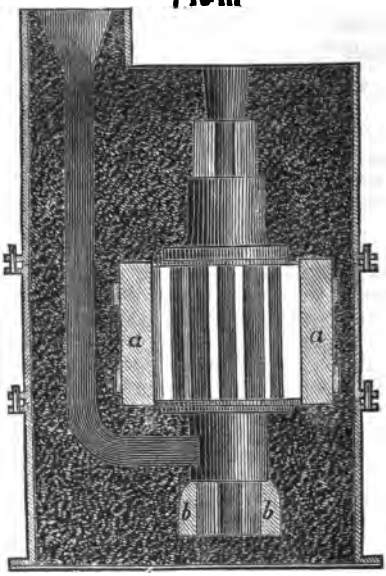
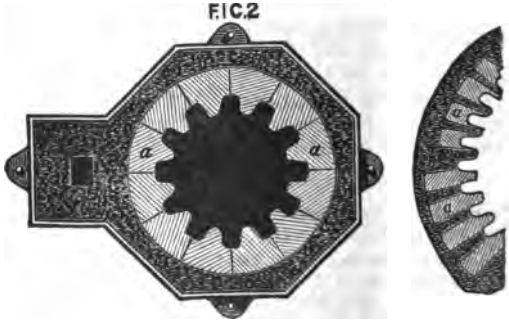


FIG. 2

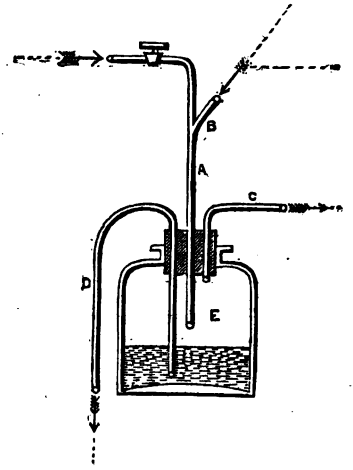


the shrouding. To prevent this, Mr. Wheeldon makes the chills used for such pinions with slightly beveled ends; and thus when the chills are expanded radially by contact

with the hot metal and the casting contracts by cooling, spaces are left between the ends of the chills and the shrouding which permit the longitudinal contraction of the casting to take place.

A FOUNTAIN BLOW-PIPE.

THE pipe A is connected with a hydrant or reservoir containing water, the flow of which is regulated by the stop-cock. Running into the bottle E of the capacity of about a litre, air is drawn through the short side branch B; the water and air separate again in the bottle, the air



escaping under pressure through C, to which, by means of India-rubber tubing, a blow-pipe is attached. The surplus water is carried off by the siphon D, and its flow is regulated so as to retain the water in the bottle at a uniform height. The pressure may be readily increased by lengthening the pipe A.

CHEMICAL SIGNAL-LAMP.

WHEN the vapor given off by burning phosphorus is brought into contact with fragments of lime heated to redness, a union takes place, the result of which is phosphide of calcium. It is a peculiar characteristic of this substance that, when it is thrown upon water, it is at once decomposed, and there is given off phosphuretted hydrogen, which at once takes fire, and burns with a bright, strong light.

This has been made available for a signal-lamp. A metal cylinder having a cone-shaped top, and a heavy metal tube projecting from the bottom, is closely fitted with a ring or block of wood, which is so adjusted as to have the greatest weight below, thus causing it to float with the cone up, however it may strike the water when thrown from the hand. This can is filled with small lumps of the phosphide of calcium, and the two ends sealed up. When the lamp is to be used, the top of the cone is to be cut off, so as to allow the gas to pass off; and the lower tube is also opened. Thus prepared, it is only needful to place it in a vessel of water, or to throw it overboard from the deck of a ship, when the water, entering through the lower tube, and coming into contact with the lime, causes it to give off the gas, which passes out from the top of the cone, catching fire and burning in spite of winds and waves.

This lamp has been adopted for naval purposes in place of the old blue-light. With a supply of these bright little signals, a ship driving before the wind may have its course marked out for miles by these floating signals of distress; thus serving to guide any vessel which may be coming to its aid. (64)

SELF-ACTING FIRE-SHUTTERS.

IT has been suggested by George H. Knight that fire-proof shutters may be made to close automatically, should fire be near enough to damage the building to which they are attached. To accomplish this, he proposes to furnish each shutter with a spring sufficiently strong to close the shutters tight when unfastened, and the hooks by which the shutters are fastened open are secured to them by very soft solder, which will run at such a heat as would cause damage to the building or its contents, and thereby allow the springs to act on the shutters. Or the fastenings may be made of two metals of different expansibility, which would spring under the action of any dangerous degree of heat, and allow the shutters to close.

TRANSFERRING PICTURES.

A METHOD of forming translucent pictures, by transferring, has been suggested by John T. Foley, which consists in printing the desired picture on a calendered paper covered with a preparation of one ounce of gum tragacanth, dissolved in eight ounces of water, to which is added twelve ounces of fresh milk, one half ounce of white sugar, and one quarter ounce of oil of almonds.

This picture is transferred in the usual manner to a glass plate coated with a preparation of copal, Zanzibar gum, and linseed oil, and after it is set, the paper is removed and the plate backed with a varnish of alcohol, Zanzibar gum, shellac, and balsam of fir. This method of preparing the picture is said to give a peculiar and beautiful effect.

PHOTO-TRIMMER.

A ROLLER cutter, suggested by Prof. S. W. Robinson, for trimming photographs, and for other purposes, is a new and convenient tool. It is made as shown in the cut, and consists of a small cutting wheel set in a handle. It is used in connection with guide patterns, made of thin sheet metal. The roller is not required to have a sharp cutting edge, as it acts by pinching the paper. The latter is laid upon a thick plate of glass or other hard substance. This tool is very highly spoken of by photographers.

A GOOD VARNISH FOR NEGATIVES.—Bleached shellac, 3 ounces, dissolved in 24 ounces of alcohol. Filter when dissolved, which takes one or two days, then add gum sandarac 1 ounce, essential oil of lavender 1½ ounces; filter again and bottle for use. Formula of M. Carey Lea. Said to be excellent.

A CHEAP AND SIMPLE BRUSH, for applying albumen solutions to plates, and for other purposes, is made by doubling a piece of cotton plush cloth, or any fabric having a long nap, over the end of a piece of glass, or a stick, and securing the cloth by slipping a small rubber-band over it, as in the cut.

DENTAL GOLD.—AS a convenient method of preparing gold for dental purposes, R. S. Williams suggests that the ordinary corrugated foil be rolled into cylindrical form, and then cut into small pellets of suitable size for plugging.

ELECTRO-PLATING WITH TIN.

To prevent the difficulty usually experienced from the precipitation of the tin to the bottom of the bath, W. E. Tilley proposes to prepare the solution by dissolving grain-tin in nitro-muriatic or nitric acid, and then evaporating the solution to dryness, after which it is added to a solution of cyanide of potassium, which is boiled for half an hour. The oxide of tin thus obtained is filtered, washed with boiling water, and evaporated or drained to a pasty consistency. To this paste is added a mixture of two parts of muriatic acid, and one of sulphuric, which will take up the oxide and hold the tin in a solution which may be diluted with soft water to the required strength for plating.

BUILDING IN WINTER.

BUILDING operations have to be suspended in severe weather, owing to the freezing of the mortar. As a means of overcoming this difficulty, Andrew Derrom proposes to build houses under a sectional movable shed, which may be raised as the walls rise, and is so made that it may be readily taken apart and put together again over the site of the next house to be built. If the weather should be extremely cold, the shed may be warmed by fire, and the workmen operate in comfort.

FIRE-PROOF IRON COLUMNS.

To prevent the injurious effects of the expansion of iron columns, and also to prevent their melting in conflagrations, W. A. Berkey makes the column of an inner core and an outer shell, the latter being large enough to leave a space between it and the core, which is filled with some non-conducting material, and enough shorter to allow of the core taking all the weight, so that the shell may expand without damage to the building. The cap of the column is made of such shape as will hide the shortness of the shell.

ARTIFICIAL STONE.

A QUICK-SETTING artificial stone, made by J. N. B. De Pouilly, consists of twenty parts of sand or gravel, five parts of fresh lime, two parts of pozzolana, one part of sulphate of lime, and a sufficient quantity of water of baryta. The sand or gravel and lime is first thoroughly mixed, then the baryta-water is added and the whole is well triturated. When the hydrate begins to form, add the sulphate of lime and pozzolana. The resulting paste is then moulded into blocks of the required form, and exposure to the air for three hours will harden them.

NEW DRY-PLATE PROCESS, WITHOUT BATH.

COLONEL STEWART WORTLEY, the well-known English photographer, has made known his new process of preparing dry plates which are as sensitive as wet plates, and are made by simply pouring a sensitized collodion over the plate, the usual bath being dispensed with. In a paper read by him before the Dry-Plate Club, the author gives the formula as follows:—Plain collodion, one ounce; pure anhydrous bromide of cadmium seven grains; nitrate of uranium, thirty grains; nitrate of silver, eighteen grains.

Samples of nitrate of uranium vary considerably, and I purify what I use in the following manner: Dissolve one part of uranium in two parts of ether, and let stand for some hours; the water of crystallization that is in the uranium will fall to the bottom of the bottle, leaving a top layer of ether containing pure uranium, and it is this top layer which is used for the preparation of the emulsion.

I think it is desirable that the nitrate of uranium should be acid, and should it not, after solution in ether, give an acid reaction to test-paper, it will be advisable to add to it a minim or two per ounce of acid. Both nitric and acetic have answered in my hands, and, on the whole, I should be inclined to recommend the former. It must be remembered that great caution is to be exercised in the use of a strong mineral acid in collodion, as, if too much is used, the film becomes rotten and breaks up in washing.

This brings me to a point which I am anxious to impress strongly upon you, namely, that to succeed with an emulsion process the first and most essential requisite is to have a collodion suited to the work. Some kinds of cotton give a collodion from which a good result can not be obtained, and I feel sure that many experimentalists fail in getting an emulsion to work satisfactorily from the use of a collodion unsuited to this peculiar work.

I prefer to use a strong alkaline developer. And here again, nitrate of uranium has its use, as it certainly enables one to use (combined with its other good qualities) a developer sufficiently strong to render the development of a dry plate no longer a tedious operation. If very sensitive negatives are required, or very rapid development, use bromide in the developer in minimum quantity; if, on the contrary, you like to be slow and sure, use plenty of bromide and take your time about the development. Again, always intensify, if intensification be required, before fixing, so as to utilize the uranium in the

film. One last point. The light in your dark-room must be as orange as possible, and a light which is quite sufficiently orange for the wet process will not be orange enough for working the emulsion process.

In conclusion, I may mention that, having been consulted by many friends as to the peculiarity of various dry-plates that they were experimenting on, I found out in many cases that the failure was due to the weakness or badness of either the pyro or the carbonate of ammonia. The pyro that is used should certainly be of the best kind, and the carbonate of ammonia, as you are doubtless aware, varies much in its qualities, and in an old sample it frequently happens that but little ammonia is present.

One of the peculiarities of the Wortley plates is, that they may be used either wet or dry. On one occasion a competitive trial was made by Colonel Wortley with his plates, and Mr. Gordon using the ordinary photo process with wet plates. Several prominent photographers were present. Thirty seconds was the time allowed to both. In all the trials the Wortley plates were pronounced equal to the wet plates, and in some instances better.

Colonel Wortley developed his plates by pouring over them a solution composed as follows: Carbonate of ammonia solution, (ninety-six to the ounce,) forty drops; bromide of potassium, (same strength,) ten drops; pyrogallic acid solution, alcohol, (same strength,) twenty drops; water, one ounce.

The image appeared as quickly as in the common wet process with the iron developer. When the details were fully out they were strengthened by the ordinary intensifier, pyrogallic acid, citric acid, and nitrate of silver.

THE annual meeting of the National Photographic Association was held at St. Louis in May, 1872. An extensive exhibition was also opened of photographic pictures by prominent artists, American and foreign, with the finest specimens of photographic apparatus. The attendance was large, the addresses excellent, and the results satisfactory.

AN Ohio photographer has suggested the employment of a revolving-turret operating-room, to be placed upon top a building. By means of a crank the turret is to be easily revolved so as to bring the light within the room at any desired angle. Improved effects are expected.

TANNIN solutions can be kept clear by adding a very little albumen and then filter.

A NEW PHOTO-MECHANICAL PRINTING PROCESS.

BY J. WATERHOUSE.—The following process is on the same principle as the processes of Tessie du Mothay, Albert, and Edwards, and may be applied to the reproduction of all kinds of subjects, whether in line or half-tone.

The following apparatus and materials will be required: Thick plates of finely-ground glass, (looking-glass plates will do;) leveling-stands and level; water bath for heating gelatine; (Clarke's or any other nursery lamp answers well;) retort-stand and evaporating dish for boiling the soap solution; spirit-lamps; filtering jug; dishes for sensitizing and washing the plates; a printing-press furnished with vulcanized India-rubber pads on the bed and tympan to prevent the plates being broken, (in default of a better, a common copying-press will answer very well;) inking slabs and rollers; black and colored printing-ink; gelatine, tannin, honey soap, (I have tried many kinds of soap, but have found this the best,) bichromate of potash, and distilled water.

To prepare the plates: having thoroughly cleaned the ground surfaces of the glass plates in the usual way, carefully level them and prepare a solution composed of gelatine, one ounce; tannin, ten grains; soap, thirty grains; distilled water, eight ounces.

First dissolve the gelatine in six ounces of the water, and, having dissolved the soap and tannin each in one ounce of hot water, mix them, and add the mixture to the hot solution of gelatine very gradually and stirring all the while. Filter through a coarse cloth into the jug, and pour, while hot, over the plates so as just to cover them. Should there be any air-bubbles, they may be removed with the point of a penknife. The plates are now left till the gelatine has set, and care should be taken that as little dust as possible falls on the plates, or holes will be formed in the film.

As soon as the gelatine is quite set, the plates are turned upside down and supported on little blocks of wood at the four corners, and left for about twelve hours to dry; when dry, the plates are sensitized in a bath of bichromate of potash—bichromate of potash, one ounce; distilled water, twenty ounces.

They may remain in this for about five minutes, and are then placed in a dark box or room, and dried with the aid of a gentle heat; when dry, they are ready to be exposed under a *reversed* negative. The time of exposure varies

from about five minutes in the sun for clear line subjects, and fifteen minutes for thin half-tone negatives, to fifteen and thirty minutes, or even longer, if the negatives are very intense. The exposure is difficult to regulate, and can only be learned from experience.

When the plate is judged to have been sufficiently exposed, the negative is removed from the frame, and the *back* of the sensitive plate is exposed to the sun for two or three minutes to thoroughly harden the *under* surface of the gelatine and prevent it from swelling up afterward. The plate is then taken out of the frame and put into a dish of clean water, and thoroughly washed with many changes of water till all the yellow bichromate salt is removed. The superfluous water is wiped off, and the plate is then ready for printing. If the subject be in line, the plate may be rolled in with tolerably stiff black ink, softened with a little olive-oil, and not too much on the roller. After the plate is inked in, the superfluous ink is removed with a damp cloth, and the surface of the plate finally wiped with a clean damp cloth to remove all traces of scumminess. The paper is laid on, and he plate pulled through the press in the ordinary way. Before inking in again, the plate is wiped with a damping-cloth. It is possible that some preparation of gum and glycerine would be a great help in keeping the plate clean in printing, but I have not found it necessary.

For prints in half-tone the process is slightly different. the plate is first rolled in with tolerably stiff black or dark ink to give depth to the shadows, and then with thinner and softer ink of the same or any different color to bring out the half-tones.

The above description embodies all the essential practical particulars of the process, but success can only be obtained by practice.

There are many other substances which may be used in combination with gelatine and bichromate of potash to prepare similar printing-plates, such as bichloride of mercury, permanganate of potash, chrome alum, etc. I have tried these; but, on the whole, I prefer the process I have given above, and believe it will give as good results as any other, and is not less simple and practical in working.

If desired, the gelatine films can be prepared so that they may be stripped off the glass and used as a tissue. This is done by using polished glass plates which have received a thin coating of wax dissolved in ether. After exposure to light under the negative, the tissue may be transferred and fastened to the surface of a stone or metal plate, as I believe is practiced in the heliotype process.

CONTINUANCE OF THE PRINTING ACTION IN CARBON TISSUE.

THE suggestion of Lieutenant Abney that the tissue should only be partially printed in the light, and the action afterward completed in the dark, is a very practicable one, and he will be glad to know that during the month of January nearly a thousand pictures were printed off in this manner, most of the negatives being only half printed in daylight in the first instance. Very dense negatives seem to require to be printed as much as this to set up a perfect action all over, otherwise the printing will only proceed in the dark in those places where the tissue has been attacked by light; with good negatives, however, *one eighth* is quite sufficient printing in the daylight—that is to say, a plate requiring eight tints need only receive one while exposed to light.

The data which Mr. Abney has given I find to be practically correct; thus, three negatives requiring three, six, twelve, and twenty-six tints of the photometer, if only printed to the extent of 3-6, 6-12, and 13-26, would then all alike require about eighteen hours preservation in the dark to be finished. An eight-tint negative giving but one tint requires to be kept about forty-two hours afterward. The pictures produced in this way are fully equal to those completely printed in the sun, and we now, therefore, never think of conducting our printing operations wholly in the daylight.

It is worthy of remark that this action is the reverse of that observed in dry sensitive plates, or in pure iodide of silver; in these the image becomes by degrees weaker, until at last it fades away altogether; while, as we have seen in the bichromated film, a faint picture once produced, very rapidly increases in vigor.—*H. B. Pritchard.*

M. MERGET'S MERCURY PRINTING PROCESS.

THE pictures are in character somewhat similar to the silver prints produced nowadays, being formed in fact by the reduction of the salts of the precious metals. A sheet of paper is coated with a salt of this nature in the same manner as an albumenized surface is treated with a nitrate of silver solution, and an image is then formed upon the surface by the transformation of some portions of the compound into a metal. This reduction is not, however, brought about by light, as in chloride of silver printing, but by means of mercury vapor; and the operation, therefore, may be conducted altogether in the dark. The salts

capable of being employed are those of gold, silver, platinum, palladium, and iridium, a substance of a deliquescent nature being mixed therewith to render them in a condition capable of being acted upon by the mercury. A photographic *cliché*, which receives some protective treatment in the first instance, collects the fumes of mercury, and is then pressed into contact with the prepared paper, when a reduction of the salts takes place in certain portions of the surface, and an image is formed.

At a recent meeting of the French Photographic Society, M. Davanne, who had been instructed by the inventor in the process, performed the whole operation of printing in the presence of the members. He employed an ammoniacal solution of nitrate of silver for exciting the paper, and transparent positives on glass to print from. These *clichés* must, it appears, have been developed with iron and not with pyrogallic acid to render them suitable; and the first step in the process is to render them thoroughly warm by placing them upon heated sheets of copper. Whilst the *cliché* is being heated, another copper-plate, perfectly clean and dry, receives a drop of mercury upon its surface, and by means of a little cotton-wool this globule is rubbed uniformly over the metal surface. The mercurized plate is next covered with a sheet of blotting-paper and placed in a horizontal position, and upon the paper is put the heated *cliché*; the hot glass at once freely vaporizes to mercury, which passes through the paper and attaches itself to the image upon the glass. About half an hour was the period necessary for the *cliché* to remain exposed to the action of the mercury vapor, and the image had then sufficient of the metallic fumes stored up in it to produce an impression. The *cliché* was afterward pressed into intimate contact with a sheet of paper coated with the ammoniacal salts of silver, and instantly, almost, a print was produced by reason of the mercury reducing the silver to a metallic state. The print was then simply toned, fixed, and washed, and in this way completed.

It is only when silver salts are employed that any toning or fixing is necessary; when salts of gold or platinum are used, a simple washing of the impression only is necessary. Thus the method, already a very simple one, is made more elementary still when these metals form the basis of the printing operations.

Until, however, the process is in a more advanced state, and actual experience has been gained of its practicability, it is impossible to form any sound judgment of its merits. (1)

ON THE EMPLOYMENT OF COLORED GLASS IN PHOTOGRAPHY.

BY DR. H. VOGEL.—Those who have essayed to obtain a second negative from a first are well aware how seldom such an effort succeeds, when it is desired that the duplicate shall have all the sharpness, softness, and depth of the original. As a rule, the second negative is hard by reason of short exposure, or flat from the reverse cause, or, again, it is often fogged. The reason of this is obvious: in the original negative the contrasts of light and shade are much stronger than they are in nature, and on this account it is difficult to hit upon the requisite amount of exposure, for the transparent portions appear too light, and the opaque parts too dark.

This difficulty has recently been overcome by M. Grasshoff, by setting up in front of the original negative a pale-green glass plate, and photographing the image through this medium. The result obtained in this way is truly surprising. I have seen prints of reproduced plates, as likewise enlarged negatives, taken in this manner by M. Grasshoff, which were exceedingly similar to the original negatives and prints, and which were certainly the best that I have seen of examples of reproduced pictures.

Another somewhat analogous application, proposed by Dr. Schultz, is to use a yellow glass plate. It happens not unfrequently that statues, busts, and similar objects have to be photographed in libraries, drawing-rooms, and other interiors, and these, especially when standing in the vicinity of the window, exhibit very bright high lights, and also exceedingly deep shadows. Even when the best chemicals are used, and particular care taken in the manipulation, a hard picture with solarized lights and inky shadows is the only result. To improve matters under these conditions, the use of a plate tinted very thinly with iodide of silver will be found very effective, for it weakens considerably the action of the high lights without, to any material degree, interfering with the character of the shadows. In this way, therefore, a much longer exposure may be given without in any way fearing for the solarization of the high lights.

The yellow glass is but a film of iodide of silver, which Dr. Schultz produces by simply allowing iodine vapor to act upon a silvered plate until the surface has assumed a yellowish tint. A perfectly transparent iodide of silver plate produced in this manner answers the purpose admirably, for it absorbs most completely the violet and indigo rays, and allows all others to pass through uninjured and unimpaired.

SILVERING PHOTO-MIRRORS.

DISSOLVE one hundred and fifty grains of nitrate of silver in six ounces of distilled water, and to this add ammonia, drop by drop, until the precipitate at first thrown down is redissolved. Now, having made a solution of caustic potash, in the proportion of two and a quarter ounces of the potash to fifty ounces of water, add of this fifteen ounces to the above silver solution; and add ammonia, as before, until the deep-brown precipitate again thrown down is redissolved. Now add twenty-nine ounces of distilled water, after which allow some solution of nitrate of silver to be dropped in (gently stirring all the while with a glass rod) until a precipitate *begins* to be formed. Previous to the immersion of the glass to be silvered dissolve one ounce of grape-sugar in ten ounces of water. This must be filtered and kept in a separate bottle. Now have ready a clean glass vessel of a size sufficient to contain the glass plate to be silvered; and, when every thing is ready, mix together the silver solution with that of the grape-sugar, in the proportion of ten of the former to one of the latter. Lower the glass down in the solution until it is a little distance from the bottom, and allow it to remain there for a period of time varying from fifteen minutes to four hours, according to the thickness of the coating of silver desired. After removing it from the bath wash with distilled water, and, when dry, polish by means of a soft pad of cotton velvet charged with rouge.

VIGNETTES UPON THE NEGATIVE.

BY M. ADAM-SALOMON.—I place behind the model to be photographed a background of a light shade. The operations of posing the sitter and focusing having been accomplished, I superpose upon the focusing-screen of the camera another similar glass plate, the ground plate outward, and upon the latter I sketch with a pencil the outline of the bust reflected thereon. This done, I withdraw the focusing-screen and put my collodion plate into the camera and secure an impression.

The operation ended, I remove my dark slide and take it into the laboratory. Here I cut out in black paper a *silhouette* or outline upon the ground glass bearing my sketch, and place it in the slide between the reverse of the collodionized plate and the ground glass in question. I then open a window, or the door of the dark laboratory, and allow the light to enter direct upon the ground glass surface for some seconds. During this period I rub

energetically over the masked surface a tuft of cotton-wool having somewhat the form of the *silhouette*, the light being again shut out after the time specified has expired. I then proceed to develop the plate in the ordinary manner.

It is important, in order that the affair should be a success, to make the slide and ground glass coincide perfectly with the measurement of the collodionized plate, and this is done by means of parallel markings.

The operation, which takes but very little time, yields excellent results, either in the production of negatives or in the printing of photographic copies. (18)

NEW METHOD FOR PARCHMENT PAPER.

VEGETABLE parchment—that is to say, parchment made by immersing blotting-paper in sulphuric acid—has often been spoken of in connection with photography. The following new method of making it has lately been described: The paper is dipped in a strong solution of alum and then dried, after which it is passed through concentrated sulphuric acid; it is then washed and dried slowly. The discoverer of this improvement (Mr. Campbell) states that paper which has been already printed on can be converted into parchment by the above process. How would it answer if applied to positive prints, either in silver or pigments? (1)

TRANSPARENT STEREO-PICTURES UPON PAPER.

THICK albumenized paper is chosen for the purpose, previously well sized. This is sensitized in the ordinary manner, and, after drying, printed under a negative in the pressure frame, the face or albumenized surface of the paper being turned away from the negative, and not placed in contact with the negative film, as usual. The printing operation must be carried on rather longer than when the face of the paper is being printed, so that an exceedingly vigorous picture is produced. The depth of the print can only be correctly judged by an examination of the paper by transmitted light, as the image is formed in the body of the paper itself and not simply upon the surface of the reverse side of the sheet.

The coloring of the picture is also proceeded with on the reverse, and not upon the albumenized face of the paper, and for this reason the laying on of the colors is very much simplified. The water-colors of Newman, or any others, may be used for the purpose. No spots or

patches are produced, for the tints spread uniformly over the paper.

For lamp and other transparency purposes, the process is especially suitable, forming handsome ornamental productions. (18-21)

PRESERVATION OF SENSITIZED ALBUMEN PAPER.

PROCESS of John C. Gray: Float the paper for one minute on Anthony's alum bath, forty grains silver to the ounce, then float on plain soft water, then on alum water, five grains to the ounce. Fume with ammonia.

Process of H. T. Anthony: Make a solution of nitrate of silver, thirty grains to the ounce of water; add to each ounce of the solution two grains of citric acid. Now add ammonia until all the citric acid is converted into citrate of silver—this citrate shows as a flocculent precipitate which must now be dissolved, nearly all, by adding C. P. nitric acid. Floating half a minute on this bath is long enough. The paper, after being excited, must be thoroughly dried and then packed close in a book, or otherwise, and it will keep in hot weather for a number of days. A slight discoloration of the silver solution does no harm, but rather works to improve the surface of the paper.

Process of H. J. Newton: Paper is floated upon the silver bath as usual; after being allowed to drip, it is again floated, back down, for a short time upon a solution of oxalic acid, five grains to the ounce of water. After drying it keeps indefinitely.

EXPERIMENTS ON THE SENSITIVENESS OF COLLODION.

HERR EMIL ZETTNOW has made a series of experiments on the sensitiveness of collodion in various proportions to its contents of pyroxyline and iodides. He prepared and tried in various ways forty-two samples, in which the amount of pyroxyline was from a quarter to one and a half per cent. The following results were obtained on comparison of the several pictures:

1. The amount of pyroxyline remaining the same, the increase of the iodine salts up to a certain point increases the sensibility; but on going on increasing beyond that point the sensibility not only diminishes, but the pictures become fogged and less defined.

2. The perfection of the picture increases with the contents of pyroxyline, and to such an extent that the improvement can no longer be ascribed to the thicker layer

of iodine and bromine formed in the case of a thick collodion.

3. All samples of collodion with from a quarter to a half per cent of paper, work less energetically than those with more.

4. Iodizing of from one and a half to two per cent gives light and shade clear and definite. Extremes, such as one half to one per cent, or, on the other hand, five per cent, give pictures not as harmoniously finished.

5. The best specimens were obtained by an exposure of from ten to twelve seconds in January, with collodion where the silver layer was just transparent.

6. The samples of collodion with three per cent of iodine and bromine—that is, four per cent of salts—gave indistinct pictures; and the other experiments with still larger amounts failed in giving good or defined results.

Practically the author recommends to prepare the collodion as thick as possible, and iodize, so as to get from one and a half to one and three quarters per cent of iodine and bromine, or about two to two and a half per cent of salts in the mixture. (1)

UTILIZING OLD COLLODION.

POUR the collodion, drop by drop, into water, stirring energetically the whole time. The gun-cotton separated in this way floats upon the surface of the water in the form of light snow-flakes, the iodizing salts falling to the bottom of the vessel.

By means of a glass rod I lift the flakes of cotton, and place them in another vessel, and wash for a short time. In order finally to remove all traces of water, the pyroxyline is then washed with alcohol, and allowed to dry. Thus obtained, the gun-cotton is to be preferred in every respect to the material freshly prepared.

The collodion produced by means of this recovered pyroxyline always remains bright nd clear; it works much more quickly, gives great detail, adheres firmly to the plate, and yields a uniform film free from structure. It also possesses the quality of clearing and restoring brightness to discolored collodion, and rendering the same again serviceable.

The price of the gun-cotton thus secured is of course somewhat high, but then it must be remembered the working quality of the collodion is thereby increased twofold.

TO EMPTY A PHOTO-BATH or other vessel without spilling, bend a piece of thick letter-paper around one edge. The same paper may be frequently used.

ARGENTO PICTURES.

THESE consist of a bichromatized gelatine carbon film, neatly placed upon a silvered metal plate, which is then covered by and cemented to a glass.

GRAPHITIZED PAPER.—To combine graphite with paper and other fibrous materials, Alonzo Hitchcock treats the latter with a bath of sulphuric acid diluted with one half the quantity of water; until the surface is turned to a gelatinous state. One or both surfaces should then be covered with pulverized graphite, and then put in a bath of alkaline liquid to neutralize the acid. Cotton, or flax-thread, or yarn, may be treated in the same manner. By mixing nitric acid with the sulphuric, raw cotton may be used.

A GOOD method of mounting photo prints is to cover a glass plate with warm gelatine solution, place the wet print thereon, and allow to dry under pressure. Optical contact between gelatine and print is thus secured, and a pleasing enamel effect is produced.

A NEW COMPOUND FROM ALBUMEN.

BY the action of a mixture of nitric and sulphuric acids on albumen a curious substitution compound was obtained, in which the radicle NO replaced, to a certain extent, hydrogen in albumen, while the sulphuric acid—or, rather, a residue of it—entered likewise into the constitution of the new body produced. This body bears some resemblance, chemically, to one of the varieties of pyroxyline; but our readers are, no doubt, aware that, when pyroxyline is treated with caustic potash or with a reducing agent, more or less pure cellulose is reproduced. Loew now finds that, when the albumen nitro compound is subjected to the action of a reducing agent, the nitrogen introduced by the previous treatment is not removed, but that the oxygen is displaced, hydrogen going in instead.

The formula of the new compound is written—

$$C_{72}\left\{\begin{matrix} H_{100} \\ (NH_2)_6 \\ SO_3, OH \end{matrix}\right\} N_{18}\, SO_{22}.$$

This complex body has the most formidable name of "*hexamido-sulph-albumenic acid.*"

The point of interest in connection with this body is that its existence and mode of formation appear to indicate that albumen contains certain bodies closely related to the benzole or "aromatic" series. When benzole, C_6

H_6, is treated with nitric acid, nitro-benzole, $C_6 H_5 (NO_2)$ is formed, and this, on treatment with sulphuretted hydrogen, becomes aniline—$C_6 H_5 (NH)_2$.

The changes effected by this treatment are similar in kind to those undergone by albumen when subjected by Loew to analogous processes. The purely theoretical considerations we need not enter into here; it is sufficient at present to know that an important step has been made in the chemistry of albumen, which, if well followed up, may lead to a knowledge of its true constitution, and ultimately to the discovery of a mode of building up this strange and important body without the intervention of the so-called vital force. (1)

RENOVATING SILVER BATHS.

THE old or defective bath liquid is poured into sound champagne bottles until four-fifths full, then corked down; each bottle is, for precaution's sake, placed in an open vessel of some sort, and then the solution allowed to freeze hard and fast in the bottles. When this is completely effected, the bottles are placed in a moderately warmed apartment to be gradually thawed, but must on no account be taken into a heated room, otherwise the glass will forthwith crack. As the contents thaw the liquid is poured off, until there remains in the bottle but a small ball of ice, about one eighth or one tenth of the original solution. This mass contains the whole of the injurious organic substances, the liquid which was thawed in the first instance being a pure solution capable of being employed without further treatment for the sensitizing of plates. The ice-ball still remaining in the bottle is not thrown away, but, after being likewise thawed, is poured into the residue receptacle.

QUICK METHOD OF SEPARATING COPPER AND SILVER.

BY R. PALM.—This method is based on the fact that silver nitrate is insoluble in concentrated nitric acid, whereas cupric nitrate is soluble. The nitric acid solution of the metals is evaporated to the consistence of a thick oil, and then mixed with concentrated nitric acid free from hydrochloric acid, whereby all the silver salt is precipitated in the crystalline state, the copper salt remaining in solution. The precipitate, which is colored blue from adhering copper salt, is obtained quite white and free from copper by two or three washings with concentrated nitric acid. The adhering acid evaporates on

drying the precipitate. Care must be taken not to evaporate the mixed nitrate solution to dryness, for it is then very difficult to wash out the copper from the precipitated silver nitrate. The more concentrated the nitric acid, the more fully is the silver salt thrown down. An acid of sp. gr. 1.25 is recommended. For every part of concentrated metallic solution three to four parts of acid are requisite for separation. (36)

NEW METHOD OF PRODUCING OZONE.

By A. Boillot.—The author describes an apparatus for producing a silent discharge of electricity, by means of which he says that he obtains a much larger quantity of ozone in oxygen than by any of the ordinary methods.

The apparatus is constructed as follows: A tube 32 cm. long and 14 mm. in diameter was covered externally over 29 cm. of its length with powdered coke which was caused to adhere by coating the tube thinly with gelatine. Another tube, 29 cm. long, and 8 mm. in diameter, and closed at both ends, was similarly covered with powdered coke, so as to form a cylinder of carbon. This tube could enter completely within the former tube, leaving a space between the two for the passage of a current of oxygen. One of these tubes was connected with one pole of an induction machine, the other tube with the other pole by means of a platinum wire, and the whole was inclosed in an outer tube of glass. With four Bunsen's elements applied to the induction coil, the silent discharge was kept up for several hours without interruption. A current of oxygen flowed through the apparatus during that time, and a large quantity of ozone was obtained. (4)

MANUFACTURE OF ANILINE COLORS WITHOUT ARSENIC.

By Girard and De Laire.—All attempts hitherto made to produce aniline red on the manufacturing scale without the use of arsenic, or to dispose economically of the arsenical residues, have proved unsuccessful. The authors therefore, taking into consideration the fact that only a small proportion, not more than one tenth, of the rosaniline manufactured is used for dyeing, the greater part being consumed in the preparation of other aniline dyes, have turned their attention to the preparation of these latter by other processes.

The process for obtaining "diphenylamine blue" (which is fully described in Watts's Supplement, p. 161) has proved commercially successful. The authors have also

obtained, without the use of arsenic, the violet colors usually produced by acting on rosaniline with alcoholic iodides, by oxidizing the secondary monamines, methylaniline, methyltoluidine, etc. They expect shortly to produce the green in a similar way. (4)

MANUFACTURE OF CHLORINE.

BY F. DE LALANDE AND MAURICE PRUD'HOMME.—When silica is heated with an alkaline or earthy chloride to a red heat in a current of oxygen or dry air, chlorine is evolved, and a silicate of the base of the chloride is formed—

$$SiO_2 + 2NaCl + O = Na_2SiO_3 + Cl_2.$$

By passing over the mixture hydrochloric acid together with the oxygen, the chloride is reproduced by the decomposition of the silicate, and thus a continuous evolution of chlorine is caused.

$$Na_2SiO_3 + 2HCl = SiO_2 + 2NaCl + H_2O.$$

The water-vapor formed in this reaction gives rise to two secondary reactions.

1. The water is decomposed by the chlorine,

$$H_2O + 2Cl = 2HCl + O.$$

2. The chloride is decomposed by the water,

$$2NaCl + H_2O = Na_2O + 2HCl.$$

Boric, stannic, and phosphoric acids, alumina, pumice-stone, fragments of brick, etc., cause the evolution of chlorine quite as well as silica.

The temperature of the reaction is higher than in Deacon's process, but the quantity of chlorine evolved is the same.

ANILINE BLACK.

BY JOHN LIGHTFOOT.—That the presence of copper in some form is absolutely necessary for the formation of aniline black, has been hitherto universally acknowledged. All black colors believed to be formed without the aid of copper really owe their formation to its presence in the vessels in which they are prepared, or in the rollers employed in printing.

Mere traces of copper are sufficient to produce a black color, but the presence of this metal in some quantity is indispensable. Cupric sulphate was first used, but for various reasons was subsequently replaced by cupric sulphide.

In order to discover the effect of employing different metals in the formation of aniline black, a number of ex-

periments were tried, a basic aniline salt being used. To ascertain if an aniline salt is acid, Dale's magenta paper is recommended, made by soaking ordinary filter-paper in a weak fuchsine solution. A trace of acid turns the red color yellow. The experimental mixture consisted of *aniline hydrochloride* and *ammonium chlorate*, thickened with starch. This mixture was printed by a wooden roller on well-bleached cotton, and whilst the fabric was still damp, the following metals were brought in contact with it, and allowed to remain so for fifteen minutes: Copper, iron, vanadium, uranium, nickel, lead, zinc, antimony, tin, manganese, chromium, bismuth, arsenic, titanium, tungsten, cadmium, tellurium, molybdenum, mercury, silver, gold, platinum, palladium, rhodium, iridium, aluminium, osmium, cobalt, ruthenium, thallium, magnesium, lithium, lanthanum, didymium, erbium, yttrium, selenium, tantalum, niobium. After this, the fabric was hung up in a warm and damp place for twelve hours, and then passed through an alkaline bath. The result was that the best black was obtained with vanadium, next with copper, then with uranium, and lastly with iron. All other metals give either very little color or none at all. A sovereign and a shilling previously found to have no effect, were shaken in a bag with some copper coins, and then placed in contact with the piece of cotton, when the sovereign produced a grey, and the shilling an almost black tint.

CONCENTRATED SUPERPHOSPHATE.

By Herm. Vohl.—Almost all superphosphates are prepared by the decomposition of the tribasic calcium phosphate by sulphuric acid, and in this way it is impossible to avoid weakening the product by the presence of calcium sulphate, $CaSO_4 + 2H_2O$. Many manufacturers find it very desirable to have at hand extremely high grade, that is, concentrated superphosphates, and these can only be obtained by preventing the formation of the hydrated calcium sulphate. To this end, a quantity of Mejillones guano was treated with dilute phosphoric acid, so that one or two molecules of lime were saturated as desired, a mixture of neutral and acid phosphates being obtained. If a very concentrated superphosphate is made it must be packed in casks, as it is very hygroscopic.

Alcohol.—As a cheap material for the manufacture of alcohol, Messrs. Rolfe and Rogers propose to use Manzanita berries, which grow in great profusion in California, and can be obtained for the cost of picking.

MAGNESIAIZED PETROLEUM.

IT is stated by E. Dennis that magnesia may be mixed with petroleum, until a paste is formed, without materially increasing the original bulk of the liquid, and that the oil thus treated may be burnt in lamps, leaving the magnesia behind, into which more oil may be poured and burnt as before. The advantage derived from the use of the magnesia is the lessening of the danger from fire should the lamp be broken.

SULPHIDE OF SODIUM.

A. K. EATON proposes to manufacture this article, by melting crude sulphate of soda in an upright retort containing carbon at its bottom, and allowing the heated sulphate to percolate through it. As the charge is melted, additional sulphate and carbon may be added at the rate of five parts of the former to one of the latter. Sawdust, chips, etc., may be used for the carbon, as it becomes converted during the process.

JAPANESE USES OF PAPER.

THE Japanese are wonderfully proficient in giving to paper the hardness and weight of heavy wood, and manipulating it in all sorts of shapes. Some of the common paper made is so tough that it can only be torn with difficulty. Coats, hats, shoes, umbrellas, boxes of all kinds, ornaments of every description, pocket-handkerchiefs, fans, etc., are made from paper; in fact, a Japanese will turn paper into a hundred useful forms. The imitation-leather paper is made by mixing oil with the pulp; in the same manner all waterproof-paper is manufactured. The juice of persimmons is sometimes also used in making paper intended to resist dampness. From that country we have directions for making paper-cloth warranted to wash, which is known by the name of "Shifu," and which are as follows:

"Take some of the paper called 'hôshô,' (used for letters, books, etc.,) or some of the best 'senka,' (paper used for making rain coats,) and dye it of the color required. Boil some of the roots called 'Ron-niaku-no-dama,' with the skins on; try them with the inner portion of a rice stalk; when it penetrates easily they are sufficiently boiled. Peel them and let the water run off, and then pound them into a paste. Spread this paste on either side of the paper, and let it dry in the sun till quite stiff. Then sprinkle water on it until it is thoroughly damped, and leave it in that state for a night. The next morning

roll it upon a bamboo of the thickness of the shaft of an arrow, and force it with the hands from either end into a crumple in the centre; unroll it, and repeat this process two or three times, rolling it from each side and corner of the paper. Then crumple it well in the hands by rubbing it together until it becomes quite soft, and then sprinkle water on it again to damp it. Pull it out straight and smooth, fold it up, and pound it with a wooden mallet. It may then be put into water, as much and as often as is liked, without sustaining injury, having become a strong and lasting material. This cloth is made principally in the Daimiate of Seudai. Boxes, trays, and even saucepans, may be made of this cloth; and saucepans thus manufactured sustain no injury over a strong charcoal heat. Bags may be made of it, in which wine may be put, and heated by insertion in boiling water. Paper thus prepared may be used for papering windows, and will withstand the rain without being oiled."

For the manufacture of oil-paper for rain-coats, etc., the paper should be that locally known as "senka" or "tosa-senka." The glue used for joining the paper is made of young fern shoots, ground and boiled into a paste, and thinned by admixture with the juice expressed from unripe persimmons. The dye is usually green, yellow, red, or black. Whichever color is used, the coloring matter—generally a powder—is boiled with bean paste, and the paper is then painted with it. The preparation of the paper consists principally in softening it by rubbing it in the hands. The oil used is a seed oil called "Ye-no-abura."

SPHEROIDAL STATE OF LIQUIDS.

MR. W. F. BARRETT has found that the presence of alkalies or soaps in water quite perceptibly aids in the production of the phenomena of the spheroidal state. He relates as one experiment, which first drew his attention to the subject, that having occasion once to cool a red-hot copper ball, he plunged it into some water in which he had just washed his hands. To his surprise, the ball entered the water without hissing and without visible evolution of steam, and on being removed was apparently as hot as before. Fresh water was tried, but with a different result. The ball, upon immersion, evolved a loud hissing sound and gave off a copious discharge of steam. By adding a little soap to the water, he was enabled to reproduce the phenomenon at first observed, the ball entering the liquid quietly. Albumen, glycerine, and organic substances generally produce the

same results. The best method of reproducing the phenomena, the author says, is to make use of a soap solution mixed with water, and to plunge into this a white-hot copper ball about two pounds in weight. The ball enters the liquid smoothly and quietly, and glows white hot at a depth of a foot or more beneath the surface. Even against so great an hydrostatic pressure, the ball will be surrounded with a shell of vapor perhaps an inch in thickness. The total reflection of the light from the bounding surfaces of the vapor bubble surrounding the glowing ball gives to the envelope the appearance of burnished silver, making the experiment quite an interesting one. As the ball gradually cools, the bounding envelope becomes thinner, and finally collapses altogether, followed by a loud report and the evolutions of large volumes of steam. From the facts elucidated by his experiments, the author makes the suggestion that the traces of oil, or other organic matters which find their way into a steam boiler, may similarly produce a sudden generation of steam sufficient to account for certain problematical explosions.

THE ACCELERATING ACTION OF LIGHT.

M. BECQUEREL first made known the law that certain colored rays of the spectrum have the power of continuing the action of light upon a film of iodide of silver. On this suggestion M. Bazin, in 1870, instituted a series of experiments with a view of shortening the time of exposure in photographic portraiture.

He first made openings in the camera, and covered them with red glass, so that red light would fall upon the plate while the picture was being taken. Recently he has suggested a further improvement. In place of the ordinary metallic diaphragm of the lens, he substitutes a diaphragm made of thin red paper, having the desired opening in the centre. Thus, in taking the picture, a certain amount of red light is admitted to the plate, in addition to the usual quantity of light. The time of exposure is thus greatly reduced; or, what is the same thing, the details are more fully brought out and the negative much improved.

Mr. Charles Gutzlaff, of Bahia, Brazil, has recently made known a similar process, and during the past year it was presented for examination to the photographic section of the American Institute, N. Y. A committee was appointed, consisting of H. J. Newton, D. C. Chapman, and S. D. Tillman, who found that the exposure of the film, either before or after taking the picture, to light

admitted through the colored glasses prepared by Mr. Gutzlaff, reduced the time of taking the picture nearly one half. Slow and long-continued actinic action they concluded to be of the highest importance in photography—a result which was attained by the use of these glasses. The committee tried a variety of experiments. Exposure of the plate, before or after taking the picture, through reflected light from differently colored cloths, held before the camera, had substantially the same effect as the colored glasses. So did the exposure of the plate to diffused white light without any coloring materials. The committee also applied the spectroscope to the camera and marked upon the ground-glass the position of the principal lines of the solar spectrum. They then tested the Gutzlaff glasses, and found that they transmitted no blue rays; nevertheless the light sent through these glasses had a strong actinic effect upon the sensitive film. A variety of other experiments satisfied the committee that there is, in fact, no light which is not actinic. Another singular fact elicited was, that the light transmitted through orange-colored glasses did not produce so quick an effect on paper sensitized with chloride of silver as the Gutzlaff glasses, which transmitted no blue rays.

NEW PROCESSES FOR STIPPLING.

An improved method of treating the backgrounds of photographic prints, suggested by Van der Weyde, of New-York, has attracted much attention during the past year. The ordinary process has involved much time on the part of the artist to rub up and duly stipple the albumenized surface; and, in fact, it has required a master's hand to produce really pleasing effects.

By the author's process, it is alleged that the most beautiful and pleasing artistic effects, heretofore requiring days for their execution, can be produced in a few minutes without the exercise of special skill. This is accomplished by rubbing over that portion of the albumenized print that is to be stippled, a mixture of two parts of powdered pumice-stone and one of crushed crayon, adding a little dry color, such as crimson lake, to impart a warm tint. It is to be rubbed in with the finger or a pad. When this has been repeatedly and evenly applied, the print is dusted off, and a little powdered pumice-stone rubbed over the surface, the effect of which is to dilute the previously applied crayon and give it a transparent effect. A little light-gray crushed crayon and crimson lake are now used, and the surface is rubbed until quite

smooth, which produces the effect of an atmospheric stipple. The effects are varied by using variously colored crayons, rubbing with chamois-skin and other pads.

Mr. Benecke has suggested a plan for printing in backgrounds, which is alleged to be equal to the foregoing. Varnish a glass and sift fine white sand upon it. The sanded glass to be used as a negative to print in the back-ground.

MANUFACTURE OF SHEET-IRON.

A NEW process of coating sheet-iron with other metals, proposed by Benjamin Morrison, consists in first removing the ordinary rough scale in the usual manner in zincing iron, and producing by heat a new and uniform oxide, then gradually heating the sheets in a closed box in a furnace to a low red-heat, and introducing hydrogen gas. In about one hour the scale will have become deoxidized, and the box may then be removed and gradually cooled, the hydrogen still pressing through to prevent the entrance of air. When cool, the sheets should be immersed for five minutes in a saturated solution of sulphate, chloride, or acetate of zinc, chloride of tin, or acetate of lead, or the solution may be applied by a sponge or soft brush. The sheets are then to be replaced in the box and furnace, and reheated as before, and the hydrogen again introduced. After heating to a low red for about half an hour, the heat should be increased to a bright red for a short time, and the box may then be withdrawn and gradually cooled, the hydrogen passing through as before until cool enough to handle, when the gas is shut off. By this process, it is said, sheet-iron is produced which is very soft and flexible, having a coating that is not liable to scale off in seaming, and less liable to rust than any sheet-iron hitherto produced in this country.

MANUFACTURE OF BRUSHES.

INSTEAD of fastening the bristles in brushes with wires, W. H. Van Kleeck proposes to set thin plates in the centre of each branch of bristles and force the plates and bristles together in the holes in the brush-blocks, thus firmly securing the bristles in place, as the plates are slightly wider than the diameter of the holes. To make the bristles still more secure, the edges of the plates may be serrated or jagged. Brushes thus made do not require a back to hide the wire or prevent the bristles working through the block, as the holes need not be made all through it.

MASHING GRAINS.

IN treating grains for mashing, C. H. Frings first grinds it very fine, then heats for fifteen minutes in a mash-tub, containing for each bushel about twenty gallons of water, and from one to two ounces of caustic soda. The heat for rice and corn should be about 185° Fah., and for rye, barley, wheat, or other grain, 155° Fah. To prevent the saccharization of the starch, or the injurious formation of lactic acid, as much muriatic acid is used—say about three ounces to one of the soda employed—as will give a marked sour reaction. If preferred, other acid may be mixed with the muriatic, instead of using it pure—phosphoric, sulphuric, nitric, oxalic, tartaric, and citric being the best for this purpose.

CLEANING COFFEE.

IN transporting coffee by sea, the outside of the bean is frequently damaged by a fungus growth, which imparts a bad flavor to the outer skin, but does not penetrate to the interior; and it has been suggested by W. H. Butler, that the outer damaged portion may be removed by scouring the bean by agitation in a vessel, whereby the outer skin is removed by attrition with the sand.

MECHANICAL COTTON-PICKER.

ZACHARIAH B. SIMS, of Bonham, Texas, is the originator of a mechanical cotton-picker, which is said to operate in the field with much success. It is to the cotton-field what the mowing-machine is to the hay-meadow. It is alleged that by means of one of these machines, operated by three men and two boys, sixteen thousand pounds of cotton can be picked per day, which is equivalent to the work of fifty persons picking by hand in the ordinary manner.

MANUFACTURE OF SUGAR.—Paul Marcellin proposes to manufacture sulphurous acid gas by the decomposition of one part of sulphur with two parts of sulphate of iron in a retort, and thus produce a pure gas which may be introduced directly into the vacuum-pan without the bad effects on the sugar caused by sulphurous acid when made in the usual manner.

JOINTED DRAWING-KNIFE.—To economize room in packing, and to prevent injury to the edge, A. M. Steele proposes to make the tangs of drawing-knives with joints, so that the handles may be turned down parallel with the blade to protect the edge from damage by accidental contact with other tools.

MANUFACTURE OF SUGAR.

To remove iron or other metal from sugar, Drummond and Hunt propose to add to the solution or syrup, milk of lime, to make it slightly alkaline, and then mix with it sulphides of barium, calcium, or strontium, at the rate of two pounds of the sulphide of barium or one of calcium to the ton of sugar, either in water or powder, at a temperature of from 100° to 150° Fah. Sulphate of magnesia is now added at the rate of three parts to two of the barium, or one of calcium, and the whole is thoroughly mixed and heated. It is next passed through a filter, and is then ready for refining in the usual manner. By this process the metals existing in the form of oxides are converted into sulphides, which are removed by filtration.

SAFE PETROLEUM.

SAMUEL HUDSON proposes to keep the condensers of oil-stills at a temperature as high as the fire-test of the oil to be produced, and allowing the inflammable gases to pass off by an escape-pipe. He also suggests that the oil remaining from the still be allowed to run down a shallow trough, where it may be exposed to the air and thus part with any volatile material it may yet retain. It is claimed that by this method a much superior oil is produced with less fuel and that the process is much simplified.

WATER-PROOFING PAPER.

A METHOD of treating paper, suggested by Cyrus B. Ayer, consists in passing it through a solution of alum, and then through a sizing composed of soft soap and a solution of one part of glue in four parts of water. thus forming an insoluble compound of alumina and fatty acids upon the surface of paper, rendering it water and damp proof. Or, instead of the solution of alum, a solution of the salts of iron or zinc, or a mixture thereof, may be substituted, and the glue may be left out of the sizing.

WRITING INK.—In manufacturing ink, it has been the custom hitherto to keep it for two or three months to "age" it and develop its color; but J. W. Carter states that this may be accomplished in a few hours by forcing fine streams of air through it. This he accomplishes by having a coil of perforated pipe in the bottom of a tank containing the ink, and forcing the air through it by a pump, blower, or otherwise.

DECORATED TIN FOR WALL-COVERINGS.

A NEW style of wall-covering, devised by J. M. Lasche, consists of tinfoil ornamented by painting or printing in oil-colors, and cemented to the walls or ceilings by a water-proof cement or varnish. By this means walls may be decorated in water-proof colors at a very low cost.

SALTPETRE IN SOUTH-AMERICA.

ACCORDING to a low calculation, there is at Tamarugal alone, where the nitre beds extend over 483 square miles, a quantity of saltpetre equal to 63,000,000 tons, sufficient at the present rate of consumption for 1393 years, while larger quantities of this salt are known to exist at the foot of the Cordilleras.'

STEAM-FLUME RACKS.

IT is very difficult in severe weather to keep the racks, used in water-flumes to prevent obstructive matters from passing through, from being stopped up by ice. To overcome this difficulty, C. W. Russell suggests that the racks be made of tubing, through which steam may be forced, whereby the ice may be prevented from forming and that formed during stoppage be melted.

CLEANING CLOCKS AND WATCHES.—A new method of cleaning clocks and watches, suggested by W. W. Thompson, consists in removing the movements from the cases, and immersing them in pure naphtha or other volatile liquid, and drawing or twirling them about in it, so that the naphtha will dissolve and wash away every thing adhering to any of the parts. The mechanism should then be dried in hot air, and gradually cooled. It is alleged that by this process time-pieces may be thoroughly cleaned without separating the works.

CARPENTERS' BRACES AND BITS.—An ingenious arrangement of these implements has been devised by J. Rice, in which the lower end of the brace has a flange surrounding it, to which the different bits are hinged in such a manner that the one to be used can be turned down under the centre of the flange, and those not required turned up out of the way.

SINGEING HOGS.—Instead of the usual method of singeing hogs with burning straw, etc., Patrick Kenny proposes to hang the carcass in a circle of furnaces from which the flames are impelled upon it in the form of jets by means of a blower or otherwise.

MAGIC PICTURES.

WE have now before us white paper on which no image can be discovered to exist either by transmitted or reflected light. No sooner is it dipped in water for a few seconds than, presto! a transparency has been formed within its pores, as water-marking. With the drying of the paper the "watermark" disappears. "How is it done?" To the answering of this question we now address ourselves.

Although any paper may be made to answer by special treatment, some descriptions are better than others. For example, a paper sized with gelatine is better than one sized with starch, and, as a consequence, English papers may, in general, be looked upon as better than those imported from France. Starch-sized paper should be immersed in hot water in which common washing soda has been dissolved, and when removed from this solution let it be well washed, then immersed in a twenty grain to the ounce hot solution of ordinary gelatine and dried. This will insure a sizing of the best kind for the purpose in hand.

To sensitize the paper float it on a solution of bichromate of potash, the exact strength of which is immaterial, any thing from a saturated solution downward. Float for a space of time, varying from two to four minutes, and when dry expose in the printing-frame under the negative, the time of exposure being much less than that required to obtain a silver print. The paper will keep well in a dark place for two or three days previous to exposure.

When removed from the printing-frame, place the prints in common cold water for a period of time sufficient to remove all the soluble or unaltered bichromate, and then immerse it in hot water to remove the unaltered gelatine; for we need scarcely remind our readers that where the light acted the gelatine will have been rendered insoluble. The shadows or transparent portions of the negative are therefore represented in the print by the maximum thickness of gelatine, none remaining on the highest lights.

When the paper becomes dry the picture is invisible except as a faint yellow tinge, which, however, can be removed by the immersion of the sheet in diluted sulphuric acid of the strength of about equal parts of acid and water, followed by washing.

When dry, the picture will be invisible. To render it apparent in all its details, it has only to be immersed in water for a few seconds, when the whites, which are denuded of their gelatinous sizing, immediately absorb

water and become translucent, this translucency becoming more and more opaque until the deepest shadows are represented. The gelatine, hard, insoluble, and resinified as it now is, resists the water in a greater or less degree, and causes a greater degree of opacity in those parts protected by it.

These pictures are transparencies, and, by care, may be made very beautiful. As we have said, they subside into plain sheets of paper when dry. If it be desired to render them permanently visible, all that is requisite is to brush or sponge them over with gum-water, when the desired effect will be secured, and, even then, they can be restored to their original versatile condition by an immersion in water sufficiently long to dissolve out the gum. There is no fear of the picture itself being impaired by this treatment.

Those of our readers who desire something unique and really elegant for window transparencies ought to try the process here described with every requisite detail; for the delicacy of the image thus obtained is very great, and the peculiar effect very pleasing. As a harmless trick with which to amuse a few friends nothing can be better; for the pictures can be made to disappear and reappear as often as desired. (1)

NEW PHOTO-REDUCING AGENT.

A QUANTITY of bisulphite of soda is dissolved in water and the solution poured on metallic zinc, and air excluded from the containing vessel. After a short time—about half an hour or so—the reaction is complete, and the fluid now contains the required hydrosulphite of soda. Nothing could be more simple, and the process can be tried by any one, since bisulphite of soda can be purchased in most towns.

This novel developer must always be used soon after preparation, though if retained in contact with zinc the solution acts energetically for a considerable time. The stopper should not be removed from the bottle more frequently than necessary, as the oxygen of the air rapidly combines with and destroys the reducing agent. These facts should be carefully borne in mind when experimenting with the new compound.

We need scarcely add that the reducing solution may be easily employed in the separation of metallic silver or gold from waste liquids; and it presents some advantage over existing methods of reducing, owing to the facility with which the reducing agent is prepared, and the ease with which the precious metal can be separated and saved. (1)

SUGAR IN PHOTOGRAPHY.

WHEN conversing a few days since with a retired sugar planter of great experience, who is devoting the evening of life to photographic pursuits as an amateur, he hinted that it was probable that the presence of salt, or chloride of soda, in many samples of sugar would likely cause some of the *contretemps* in dry-plate or preservative processes of which from time to time photographers were in the habit of complaining. The presence of salt in the preservative of a dry plate is quite fatal to sensitiveness.

Demerara sugar is said to be more strongly impregnated with chloride of soda than any other kind in use. This arises from the fact that the ground in which the canes grow is frequently charged with saline spray from the ocean, the sugar canes thus imbibing the salt to a great extent. For the benefit of those who desire to try photographic experiments with sugar we present the following digest of its properties: Cold water dissolves one third of its weight of sugar; rectified spirit of wine (cold) dissolves it slowly, but four parts of boiling spirit will quickly dissolve one part of sugar; it dissolves in eighty parts of boiling absolute alcohol, although several writers have not recognized this fact; a gentle heat fuses it, and converts it into barley sugar; a heat of 400° Fahr. converts it into caramel; the tendency to crystallization is lessened by long boiling with water; the aqueous solution dissolves, with facility, alkalies, earths, and many metallic oxides. These notes may be useful to those who are experimenting with saccharine preservatives. (1)

PHOTO-ENGRAVING ON METALS.

A PROCESS for engraving on metal, suggested by McGill and Pine, consists in coating a silver-plate with a film of the iodide of silver, which is then exposed in a camera, or under a negative, until a faint image is formed. The plate is next electro-plated with copper, which, however, will only attach itself to those parts which have been exposed by the action of light, the unexposed portions remaining non-conductors. The plate is now etched with a solution composed of sulphuric acid saturated with nitrate of potash, which attacks the silver, but does not act on the copper. After etching the required depth, the copper may be readily removed by *aqua regia*, leaving a finely-etched image on the silver plate. To engrave on steel, gold, or copper, the surfaces are first coated with silver, and then treated as above, except that different acids are used according to the base to be acted on after the silver-plating is etched through.

DECALCOMANIE OR TRANSFERRING.

A CONVENIENT method of transferring, devised by Richard Parke, consists in giving paper two coats of a size, formed by dissolving two ounces of glue in a half-gallon of water, to which is added a half-pound of dissolved starch, and four table-spoonfuls of glycerine, then printing the required design on this paper in one or more colors. The transfer is effected by damping the paper, and placing the print on the object to be ornamented, the surface of which should have previously received a coat of varnish. The printed matter will adhere to the varnish, and may be renewed.

MANUFACTURE OF TEA-TRAYS.

THE iron used by the Newark Tea-Tray Company is made expressly for the company by a Pittsburg (Pa.) iron firm, and the grade of this iron, it is said, is better than that used in the making of the English trays. In producing a tray the iron is cut in oval shape by means of a pair of circular shears, in the style and size required, from 10 to 28 inches in length. It is then placed under a large stamping-press, (three or four plates may be placed under this press at the same time.) The drop-hammer of this machine weighs 1000 pounds, and in its fall is capable of giving a pressure of 36,000 pounds. The plates are now blank trays, the edges of which are turned down and wired by a very ingenious little machine, designed by Mr. Conger. Each tray is then set. This is done by hammering by hand, to take out any unevenness that may exist in the metal. After this the trays are cleaned, and, if found free from defects, are ready to receive three coats of japanning, and placed in an oven for twelve hours with a temperature of 500° Fahr. After coming from this oven they are "knotted"—that is, rubbed down with pumice-stone and circular brushes run by steam-pow r, then ground; the last is a secret process of Mr. Conger. After this the tray receives a coat of enamel composition. The utmost care is used in this process; the windows and doors of the apartment are kept closed; the floor immersed in water; the workmen not even permitted to wear any clothes, as the smallest speck of dust or lint would spoil the labor previously expended, and greatly depreciate the value of the tray. The enamelling being complete, the tray is sent to another apartment for ornamentation. This work, though done mostly by boys, is a very tasteful operation. The tray is then baked about twelve hours, when it receives a coat of varnish over the ornamented edge only, to retain the ornamental designs.

and baked again; this last process perfecting them for the storeroom, where each tray is examined, and those not up to the standard are rejected. They are then packed in paper bags, numbered and marked, and are ready for sale. (39)

MANUFACTURE OF CONCAVE GLASS.

GLASS plates are usually bent in moulds, and the lustre is diminished by the contact. To prevent this, Messrs. Carstens & Schwencke propose to use a frame which supports only the edges of the glass. By applying the proper amount of heat to a glass plate so supported, the centre sinks down, and if the frame is occasionally turned so as to heat the glass regularly, the concavity will be as perfect as if produced by a mould, and the surface will have a much superior lustre.

IMITATION GOLD VARNISH.

As a substitute for the expensive "gold varnish" used on ornamented tin ware, R. Parke proposes a compound made of half a gallon of turpentine, half a gill of asphaltum, two ounces of yellow aniline, four ounces of umber, one gallon of turpentine varnish, and a half pound of gamboge, mixed and boiled for ten hours. This, it is said, will have as good an effect as the gold varnish and is very cheap.

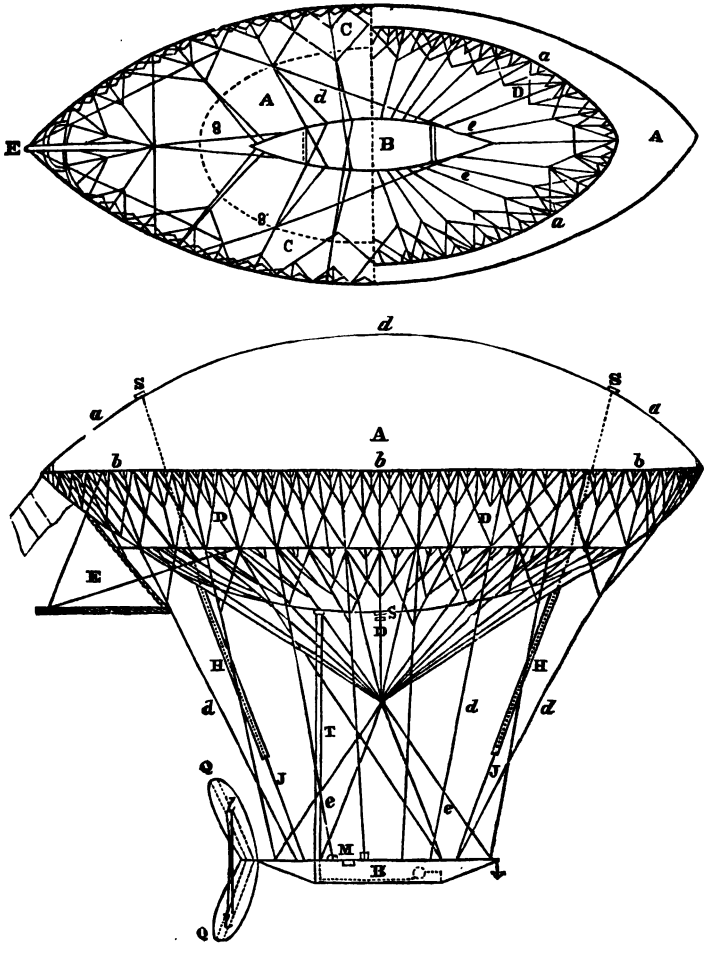
IMPROVEMENT IN THE BURNING OF POTTERY.

To save the heat usually lost in open kilns by its passing away with the products of combustion, George C. Hicks proposes to use closed kilns and supply air to promote combustion by a blast. The pressure and heat are equalized by a safety-valve on the top, which may be increased or diminished to suit the state of the material being burnt. By this process, it is claimed, that not only is fuel saved, but less loss is caused by unequal burning, as all parts are heated alike.

COMPOUND FOR CASTS.

A COMPOUND said to present a beautiful semi-transparent, white appearance, well suited for forming casts of fancy articles, suggested by Henry Hirsch, consists of unbaked gypsum, two parts; bleached beeswax, one part; paraffine, one part. This compound becomes plastic at a temperature of about 120°, and articles cast from it retain a certain degree of toughness, owing to the beeswax contained therein.

the pendant tubes, were it not that a valve, opening at a low pressure, is attached to the ballonnet. The ultimate



A, the balloon; B, the car, with D, the net-work; *a a*, taffetas covering; *b b*, collar attaching the upper netting to the covering of balloon; *d d* silken ropes suspending the car; *e e*, balance ropes for the car; *f*, small internal balloon; *g g*, line of intersection of the balloon with that of small internal balloon; E, gaff-sail, or rudder; H, pendant tubes, the length of which regulate height of the column of hydrogen; J, the cords regulating the valves S; T, tube for filling small balloon with air; M, crank for working the screw Q; *l*, stays, strengthening the screw

proportions of the aërostat, as given by M. Dupuy de Lôme, are—

Height from top of balloon to keel of car, 95½ feet.

Distance between screw-shaft and major axis of balloon, 67.1 feet.

Distance of major axis from centre of gravity of complete machine, (without ballast,) 51 feet.

The rudder is a triangular sail of 161½ square feet area, manipulated by cords from the car.

We come now to the description of the journey actually undertaken in this machine, premising that instances of so complete a fulfillment of calculation are very rarely occurrent.

The ascent took place from the Fort Neuf of Vincennes. The crew consisted of 14 men, with baggage and provisions weighing 1.13 tons. There were on board MM. Dupuy de Lôme, Zédé, (Ingénieur de la Marine,) Yon, and Dartois, aëronauts. The instruments weighed 1.75 tons, and there were 0.27 ton of packages to be carried to the destination of the balloon. The total weight, with 0.59 ton of available ballast, amounted to 3.74 tons, and the balloon, when thus ballasted, had an ascensional force sufficient to keep it in equilibrium close to the ground. In the first ascent 3 cwts. of ballast were thrown out, the balloon rising from the earth on February 2d, 1872, at 1 o'clock. From 1 o'clock to about a quarter past but little more was done than to admire the graceful evolutions of the machine, and the readiness with which it answered to both helm and screw. At 1 hour 15 minutes observations were commenced, and showed the car to be 1837 feet above the departure station, and moving in a north-easterly direction with a speed of 39 feet per second. The course was then altered to the south-east, at an angle of 83°, with the former direction. The number of men working the serew, at 25 revolutions per minute, was eight, the aërostat moving with regard to the earth at a speed of 52.5 feet per second. Afterward this speed increased, with 27.5 revolutions of the screw per minute, to 55.8 feet per second. The speeds given by the form of anemometer employed, as due to the balloon, or rather to the screw, were 7.7 feet to 9.3 feet. The descent was commenced at 2 hours 35 minutes, and was effected at the destination, Mondecourt, near Noyon, without any shock or the slightest accident. We should now consider the results that have been attained in the experiments with the aërostat. They are—the maintenance of a constant exterior surface by means of the ballonnet; freedom from rocking motion, even while two or three persons are

walking in the car; and a perfect control, the head of the aërostat being shifted to or kept in any direction, with a maximum force of 60 kilos. from the manual labor of the eight men.

These are the mechanical improvements that have been achieved; but the most important result is that an impetus will be given to the study of aërial navigation now that the science has found a theory seldom paralleled in its application. The remark of one of our greatest men, "Impossibile; I don't know the word," has indeed been practically shown to be an admitted principle by M. de Lôme.

M. de Lôme further proposes to remove seven of the eight men employed to work the screw, and substitute an engine of eight horse-power, with one man as engineer. The ballast would then consist of the fuel and water, while the aërostat could be impelled at the rate of 14 miles per hour, at a much larger angle, with the plane of direction of the wind. There has thus now been opened to us a new path in the science of aërostation, and it is difficult to limit the imagination to those new wonders we may expect within even a few more years. (26)

PRINTING TEXTILE FABRICS.

A NEW method of printing woven or other fabrics has been suggested by E. A. D. Guichard, in which the usual treatment of the articles to be printed by reagents, dyeing, steaming, or washing is dispensed with. The process consists in the use of a compound, or "sauce," of thirteen parts of oil varnish, five of essence of turpentine, one of yellow or white wax, and one of resin, which is mixed with the required colors and ground in linseed oil. With colors so prepared any kind of fabric may be printed, and no further treatment is required to set the colors either before or after printing, and the finished article will not have the "pasty" appearance common to fabrics printed in oil-colors in the ordinary way.

PNEUMATIC ELEVATOR.

As a means of moving wool, cotton, etc., from the ground floor of warehouses and factories to the upper floors, John Penman suggests that a pneumatic tube be used, having in some portion of its length a fan or blower which shall draw the fibres in at the lower end of tube, and drive them through the other into the appropriate bin or room—the upper portion of the tube having devices which will turn the fibres into any desired room or bin.

THE SMOKE-RESPIRATOR.

THIS is one of the latest novelties for the use of firemen, and is employed by the fire department of London. It enables a man to penetrate rooms and vaults, when thick smoke and deleterious gases render it impossible for any one to venture with or without the extincteur. In construction, its general simplicity is very striking, and its efficiency has been fully established by personal experiments, made both by Captain Shaw and Professor Tyndall, the suggester of the invention, who recently remained in a vault for half an hour, where layers of dry wood, dead leaves, brown paper, tar, and other similar materials were burning, until the place became dark as night. This article which is an adaptation of Tyndall's respirator to Barton's face-piece and hood, consists of a canvas hood-covering, fitting to the shape of the head, and falling over the shoulders and chest, so that it can be tucked down inside the coat. Ordinary glass eyes are supplied, and at the mouth a respirator is fixed with a leather strap. This respirator is cylindrical in form, and about the size of a quarter-pound mustard tin, at the bottom of which is a perforated plate to admit breathing air. Inside this case is placed in layers, first, some dry wool, covered with a single piece of flannel soaked with glycerine, above which is added some more wool, and then fine charcoal, above which are again piled similar layers, as above described. Inside the cap, to keep it easy fitting and air-tight, India-rubber tubes filled with water are so placed as to encushion the circumference of the face, and again the nose and mouth. In breathing, the inspiration draws up the air from the bottom of the respirator, and as it passes through

the filter, the wool arrests the dry floating particles that fill the air, the glycerine of the flannel catches the deleterious matter, and the charcoal seizes upon the creosote, so that it emerges into a vacuum at the top pure and breathable. From thence it is drawn into the mouth through an India-rubber disk valve, and the exhausted air is expelled through a projected outlet at the side, fitted with a mush-room valve. These useful articles are sold neatly packed in small tin cases.

NEW SAFE-FILLINGS.

ITACOLUMITE, a laminated granular quartz rock, consisting mainly of sand with a little talc, has been suggested as a good material for filling safes and lining furnaces, by A. C. Hamlin. It may be used either in its natural lamina or in powder.

Another filling for safes, proposed by Charles Berger, consists of hard-wood ashes which have been exposed to the air, under cover, for several months, mixed with asbestos.

Magnesite has also been suggested as a filling for safes by John F. Wood. It may either be burned or used in its native state, and then powdered and moistened with water.

The fillings of the largest proportion of the safes at present in use are composed of ordinary hydraulic cement and sand. In some safes plaster of Paris is the filling used; in others, alum and plaster of Paris. The so-called steam-safe is filled with hydraulic cement, and the inner walls of the safe, within the filling, are lined with cans containing water. Under a certain temperature, the seals of these cans melt, and steam escapes within the safe, the contents being preserved until the water has evaporated.

ORNAMENTING GLASS.

A PROCESS for frosting glass, suggested by William A. Fisher, consists in treating it in the following manner: Dissolve one eighth of an ounce of caustic potash in a small quantity of water, add a few drops of fluoric acid, and mix with a solution of one quart of concentrated sulphuric acid in three quarts of soft water. Then take fluor-spar and mix with above until a paste is formed of the proper consistency to spread with a brush. The glass to be ornamented is coated with this paste and dried, then covered with stencil-plates and the composition appearing through the interstices removed with a brush. The glass is now heated to 110° Fahr. for twenty minutes, and when cleaned it will be found that the portions covered with the compound will be frosted, but the parts from which it was removed will remain of its original brightness.

PAINT AND PUTTY.

COMPOUNDS for the above are made by R. M. Breinig in the following manner: First make oleates of zinc or lead, by saponifying cotton and linseed oils, and with this substance mix a solution of a metallic salt that will unite with the fatty acid and separate the alkali. Then mix one hundred pounds of the linseed oleate with fifty of the cotton seed, and heat with a steam coil to 200° Fahr., until all the water is driven off. Next add twenty gallons of yellow refined cotton-seed oil and twenty of raw oil, and again heat to 200°; then add forty gallons of each and heat as before. After this add gradually forty gallons of cotton-seed oil and twenty of raw oil, keeping up the heat to 200° until all the water has passed off; then cool and add sufficient whiting or pulverized marble to make it of the consistency of putty. To make paint the same process is used, except that the linseed oleate is left out, refined oil is used in place of the raw, and a quantity of anhydrous sulphate of zinc is added during the heating. When cool any desired pigment may be added.

MAKING HOSE-PIPES.

A NEW method of making hose, suggested by T. L. Reed, consists in using a core either in the form of a solid rod or a closely wound spiral spring covered with braiding, which core is coated with a composition of resin, beeswax, and Spanish brown. Over this core, when so prepared, is laid a coating of rubber, which is surrounded by braiding, and over all another coating of rubber, after which the hose is vulcanized. The core may be removed by re-heating, as the composition coating will melt out, leaving the core smaller than the bore of the hose. The first layer of rubber is closed at the ends to prevent the coating of the core from running during the process of vulcanizing.

BUTTON-HOLE STITCH.—In button-holes worked by machine, especially in leather-work, the material is very much cut up, owing to the large size of the needles used and the holes all being made in a line parallel with the edge of the button-hole. To obviate this, D. W. G. Humphrey suggests that every other stitch be set a little further from the edges of the button-hole, so that the perforations made by the needle will be in two rows, thus ∴∴∴∴. By this means the binding threads may be laid much closer together without cutting the material by the needle than can be done with the old style of machine-work.

PROTECTING SAFES.

ROWELL & DUNCAN propose to protect safes from robbery by inclosing them in closets connected by wires with a battery and an alarm in such a manner that whenever the circuit is broken the alarm—which may be at any distance from the closet—is immediately sounded. The closing of the door completes the circuit and the opening thereof breaks it and so gives the alarm. To give notice if the walls are being cut, the closet is built up of sheet-iron sections, made double so as to have air-spaces, which are all connected by tubes. One of the inner sides of these sections is perforated and the opening covered by an air-tight flexible disk, which is so arranged as to break the circuit when the pressure of air in the air-space is upon it. When the safe and closet are closed, the air within the space is drawn out by pumping, which, acting on the disk, closes the circuit, and any attempt to cut through the walls of the closet allows the air to enter and press on the disk, thereby breaking the circuit and giving an alarm.

MANUFACTURE OF SULPHATE OF LEAD.

As a substitute for "white-lead" (the carbonate) H. A. Whiting proposes to manufacture sulphate of lead by the following process: The lead is first alloyed with one per cent of zinc, and to each part by weight is added two parts of concentrated sulphuric acid, and the two heated in a porcelain pot, set in a cast-iron tub over a furnace, to 620° Fahr., or the boiling point of the acid. In a short time reaction will take place, and after it is completed all the lead in the pot will have combined with the acid to form a dingy white residue, which is sulphate of lead. The pot and its contents are then cooled and water added, cautiously at first, but in large quantities when the spitting and bubbling cease, until sufficient water is in the pot to allow of thorough stirring and washing. The lead is now allowed to settle, and is repeatedly washed with clear water until the washings no longer taste acid. The sulphate of lead is then put in clean clay moulds, and after being dried in an oven, heated to 185° Fahr., it is calcined in a muffle furnace for about half an hour at a red heat, at the close of which the cakes of sulphate of lead will be ready for the subsequent operations of grinding and mixing usual with the carbonate of lead.

PREVENTING BOILER INCRUSTATIONS.—P. V. Vigier proposes to add to the water in the boiler, in proportion to its impurity, a quantity of powdered steatite, or soapstone, which he claims is very effectual in preventing the incrustation, besides being very cheap.

DEODORIZING PETROLEUM.

IT is stated by Messrs. Mengel & Pöhrnhoff, that oil may be deodorized without the use of lead and sulphur, by heating it in a still to the point of distillation, and while thus heated, dropping water, drop by drop, on to the surface of the heated oil—the number of dripping devices varying with the size of the still and the quantity of oil in it. This produces evaporation and a partial decomposition of the water, and the vapors thus formed are condensed in any convenient manner, and an illuminating oil obtained from the crude material which may be deodorized without the use of lead and sulphur, heretofore considered necessary in refining oil, the use of which deterioates its burning qualities.

PROPERTIES OF IRON.

M. LENZ has lately submitted a valuable paper on the properties of iron deposited by the electric current. He arrives at the following conclusions: That iron and copper deposited by the galvanic current retain a gas, principally hydrogen. The volume of the gas absorbed by the iron varies between very wide limits, being sometimes as much as 185 times its own volume. The absorption of the gas takes place principally in the first layers of metal deposited. The absorbed gas may be disengaged by heating the iron to a temperature of 100° C. These researches are likely to throw great light upon the electrolytic deposition of metals, and the obtaining of a reguline deposit.

GENERATING OZONE.

THEODORE A. HOFFMAN proposes to generate ozone by forcing air through a mixture of sulphuric acid and permanganate or hypermanganate of potash in a closed vessel, from which it passes decomposed as ozone or ozonized air into another closed vessel, where it is washed, after which it may be passed through fermented or fermenting liquids, or vegetable or animal oils, to improve the taste or quality.

NEW EXPLOSIVE COMPOUND.

A COMPOUND which is said to be as powerful as nitro-glycerine, but without its liability to explosion from concussion, agitation, or spontaneous decomposition, has been devised by Carl W. Volney, which is prepared by dissolving three parts of nitro-toluol or nitro-benzole in seven parts of nitro-glycerine. This nitro-toluol, or nitro-benzole, is prepared in the same manner as nitro-glycerine, but benzole is substituted for the glycerine, and nitric acid for the nitro-sulphuric.

GLASS-LINED IRON PIPES.

THIS is a new and valuable manufacture now carried on in this city by the Glass-Lined Pipe and Tube Company of New-York. Through these pipes the water comes in contact with nothing but glass, and can not become impregnated with any oxide, as in all metallic pipes; there being no oxidation or corrosion, their purity and durability can not be questioned. The inner surface of the pipes being perfectly smooth, there is no friction, and the flow of water is greater, and can be carried up in houses with less pressure than through any other pipe of the same diameter. The lining between the iron pipe and the glass tube inside consists of plaster of Paris, a non-conductor of heat; this prevents the water therein from freezing in winter, and keeps it cooler in summer, thus saving these pipes from bursting. The lining in the pipes is protected against any moisture by a layer of hydraulic cement, which is put on the end of each length of pipe, thus preventing the plaster of Paris from being affected. The resisting power of the glass-lined pipe is five times greater than lead, and the difference in the expansion and contraction between iron and glass is overcome by the compressible plastic substance between the two materials. The glass-lined pipes are invaluable for conveying chemicals or any other liquids that are to be kept free from impurities, and also for ale and beer pumps, condensing of salt water on steamers, purifying gas, and for numerous other purposes. It is a fact well known that quite a percentage of gas escapes through the pores of the iron. When lined with glass this waste is prevented, and the pipes rendered much more durable. Great expense for continual repairs is almost entirely overcome, and the cost of this pipe is not much above lead pipe. (35)

OPERATING THE HYDRAULIC PRESS.

M. F. TOMMASI has endeavored to show the possibility of converting into dynamic work the expansion produced in liquids by heat, and the easy application of this motive force to the hydraulic press. He endeavors to show that by the expansion of oil instead of water, the pressure being caused to act directly upon the piston of the press, five tenths of the quantity of heat employed in the ordinary steam-engine produces the same degree of tension. The apparatus is very simple, consisting merely of a boiler in communication with a piston-box, the boiler being filled with colza or other oil, and heated by means of gas. It would appear that there is effected over other machines a saving of about 75 per cent.

ADULTERATION OF CHEMICALS.

ACETIC acid is frequently weakened with water, and adulterated with sulphuric acid. Six samples tested with chloride of barium gave a precipitate of sulphate of barium in varying proportions.

Muriatic acid and sulphuric acid, sold as chemically pure, have both been found contaminated; the former with arsenious and sulphurous acids, the latter with a large proportion of sulphate of lead.

Tartaric acid has been met with containing 50 per cent of sulphate of magnesia. Alum is also said to be used as an adulterant, but the reporter had not met with a specimen.

Alum frequently contains iron, probably arising from carelessness in the manufacture. The presence of free acid has also been noticed, especially in the English article.

Carbonate of ammonia is sometimes substituted by a compound made from solution of ammonia, glue, and bicarbonate of soda, which forms when dry a hard translucent mass resembling genuine carbonate.

Muriate of ammonia is sometimes met with of very poor quality; iron is often visible on the surface, and becomes still more so when dissolved. The reporter recommends that the purified granular salt should be the only one sold at the dispensing counter.

Black sulphuret of antimony has been met with containing sulphide of lead, (galena,) quartz, (30 to 40 per cent,) clay, etc. A good article, however, is procurable.

Powdered arsenic is sometimes adulterated with sulphate of lime or sulphate of baryta; the pharmacist is, therefore, recommended to purchase the lump arsenious acid.

Bismuth (metal) generally contains arsenic. An instance is mentioned in the report where 400 lbs. of antimony were sold by a broker to a manufacturer for bismuth. Fortunately for the latter, he detected the error before the transaction was completed.

Subnitrate of bismuth has been reported as adulterated with 20 per cent of phosphate of lime; but it is believed that the salt made in the United States by the principal manufacturers is free from adulteration.

Citrate of iron and quinine is seldom found made strictly according to the United States formula, which does not produce a sufficiently soluble salt. Some manufacturers, therefore, add citrate of ammonia to make it soluble, and others leave out a considerable portion of the quinine to accomplish the same end. There is also a probability

that in some cases cinchonine is substituted for the quinine.

Chloral hydrate has been met with containing the alcoholate. The tests pointed out are the difference in boiling-point, sulphuric acid, which leaves pure hydrate colorless, but turns alcoholate brown, and nitric acid, which gives little or no reaction with hydrate, but reacts violently with alcoholate, giving off nitrous oxide gas.

Chloride of calcium has been noticed at Chicago with a large excess of caustic lime, and it is known to have been sold in crystals without any allowance made.

Chloroform is sometimes met with diluted with alcohol, and sometimes not sufficiently purified, and, therefore, unfit for inhalation. There is also reason to believe that partially decomposed chloroform has been sold through ignorance on the part of the dispenser. Nitrate of silver is useful in detecting this decomposition, by giving a precipitate of chloride of silver with the liberated chlorine.

Cream of tartar is grossly adulterated, and the distinctive terms are said to be well known to mean varying proportions of *terra alba* and cream of tartar.

Epsom salt has been substituted in the Western market by finely crystallized Glauber's salt. As the prices, however, are now about the same, this is not likely to recur.

Ether is sometimes sold containing a large proportion of alcohol. This may probably arise from the druggist dispensing photographic concentrated ether, made to contain alcohol in order to dissolve the gun-cotton.

Iodoform has been noticed of a light canary color, a considerable portion being insoluble in ether; probably iodate of lime.

Acetate of lead has been in the market containing a large percentage of crystallized nitrate of lead; one lot was offered, to a maker of preparations for the hair, as "damaged," which proved to be damaged sulphate of zinc, in lumps.

Precipitated carbonate of lime has been offered containing sufficient iron to give it a light fawn color; supposed to be ordinary chalk, dressed.

Sulphate of morphia is frequently open to suspicion. In one case the sample did not contain any morphia; placed on a red-hot plate, it did not seem to lose any weight, and it was insoluble in water. A fraud in which sulphate of quinine was put into sulphate of morphia bottles has been lately detected in New-York.

Phosphorus, according to Dr. Rademaker, sometimes contains arsenic.

Bromide of potassium has been observed to contain a considerable quantity of water of hydration.

Iodide of potassium is often adulterated with the bromide; some made in New-York was found to contain carbonates in considerable quantity.

Sulphate of quinine has many adulterants; among them sulphate of lime; cinchonine, sold as "sweet quinine" or as "cinchoquinine;" muriate of cinchonine, sold as "light sulphate of quinine" and as "French quinine," salicine, etc.

Rochelle salt has been offered for sale containing at least 25 per cent of sulphate of soda.

Santonine was seen last year, in the New-York market, contaminated with small particles of mica. This fraud may easily be detected by placing the suspected sample on a hot plate: the santonine will disappear and leave the mica.

Nitrate of silver, (made for the Government,) which contained 5 per cent of copper, was sold in Chicago. Pieces could be picked out emerald-green in color; it appeared to have been made by simply dissolving coin or other alloy of silver in nitric acid, and crystallizing without any attempt at purification.

Precipitated sulphur is reported as usually free from sulphate of lime, and the United States pharmacist is congratulated on this superiority to the English article; but a proportion of 50 per cent of gypsum in flowers of sulphur is reported as having been noticed, and sometimes ground sulphur is sold for the sublimed.

Tartar emetic has been met with containing 11 per cent of cream of tartar.

Spices, on account of their widely extended use, are largely adulterated, and some startling revelations might be made if a spice-miller could be persuaded to disgorge his ill-gotten knowledge. The only safe way to get pure powdered drugs is to pay a good price, and buy from conscientious persons who are above suspicion.

Cochineal is adulterated with sulphate of barytes, a heavy white powder, which, when shaken with the insects, lodges in the wrinkles and crevices on the surface of the body. The weight is thus increased sometimes from 15 to 25 per cent.

Balsam of copaiba is often mixed, and sometimes found entirely fictitious, being composed of a mixture of castor-oil, resin, and oil of copaiba. Powdered ipecacuanha is sometimes so adulterated and weakened that tartar emetic is necessary to strengthen it. Oil of lemon mixed with 30 per cent of fixed oil has been met with.

Powdered opium is often mixed with powdered extract of liquorice. In fact, some dealers uniformly send to the grinders a certain proportion of liquorice with the opium, so that they might be ground together. Powdered rhubarb is frequently adulterated with curcuma. Sometimes senega root is mixed with cypripedium.

Castile soap frequently contains an undue proportion of water. It has been met with containing as much as 30 per cent. Acetic acid is also mixed with water, acidulated with dilute sulphuric acid.

Subnitrate of bismuth has been found mixed with phosphate of lime to the extent of 20 per cent; and citrate of iron and quinine is adulterated with citrate of ammonia, and contains less quinine than called for, 10 or 15 per cent instead of 25 per cent. Quinine itself is frequently met with mixed with cinchona, muriate of cinchona, and salicine.

Santonine has been found adulterated with small particles of mica, and cream of tartar frequently mixed with tartar emetic. Cream of tartar is grossly adulterated; the terms "strictly pure, pure, No. 1, and No. 2" being used to indicate varying proportions of cream of tartar and *terra alba*, the latter material being largely imported from Europe for the express purpose of adulterating, the importations amounting to many tons annually.

Chloroform is sometimes diluted with alcohol, and iodide of potash in crystals mixed with bromide, and occasionally with bicarbonate of potash. Solid extracts are also much adulterated.

In the manufacture of syrup, a considerable portion of the sugar is replaced by glucose, especially in making fruit syrups. (81)

EXPLOSION OF DETONATING COMPOUNDS.

By P. Champion and H. Pellet.—The detonator employed was iodide of nitrogen, which the authors found particularly suitable for delicate experiments. Small quantities of the iodide were placed at each end of a tube, and it was found that an explosion produced at one end of the tube immediately caused the explosion of the iodide at the other end. If the tube is divided, and the parts separated by an interval of five or six millimetres, the second explosion is not produced, or can only be obtained by using a comparatively large quantity of the iodide for the first explosion.

Iodide of nitrogen was fastened by means of a morsel of gold-beaters' skin to the strings of a thorough-bass violin. It was found on bowing the strings that the iodide which

was placed on the two lower strings did not explode, while that placed on the string giving the highest note exploded instantly on being touched with the bow. On trial it was found that the lowest number of vibrations that would produce an explosion was about 30 per second.

Experiments were also made with the vibrations of metallic plates and with two small Chinese gongs. The result was the same. Vibrations that gave deep sounds had no effect; but those giving the higher sounds readily produced an explosion.

The experiments above described illustrate the effect of vibrations in causing explosion of a detonator. The following show that heat, unless it is accompanied with mechanical vibrations of the proper kind, does not produce explosions with readiness.

Iodide of nitrogen was placed at the focus of a parabolic mirror, and at the focus of a second similar mirror, nitro-glycerin, fulminate of mercury, and gunpowder were exploded. The quantity of nitro-glycerin necessary to cause the explosion of the iodide of nitrogen in the other focus was determined; and it was found that as much powder was required as would produce ten times the heat given out in the burning of the required quantity of nitro-glycerin. The mirrors were afterward covered with lampblack, and then even this large quantity of powder would not cause the iodide of nitrogen to explode. On the other hand, the lampblack covering did not in the least prevent the nitro-glycerin in one focus from exploding the iodide of the nitrogen in the other.

From these experiments the authors conclude that the cause of the explosion of detonants produced by influence is generally a kind of vibratory motion, and that the nature of the motion necessary depends upon the nature of the explosive. (4)

ALCOHOL FROM SAWDUST.

In an ordinary steam-boiler, heated by means of steam, were introduced 9 cwts. of very wet sawdust, 10.7 cwts. of hydrochloric acid, (sp. gr. = 1.18,) and 30 cwts. of water; after eleven hours' boiling, there was formed 19.67 per cent of grape-sugar. The acid was next saturated with chalk, so as to leave in the liquid only a small quantity, ($\frac{1}{2}$ degree by Ludersdorf's acid areometer;) when the saccharine liquid was cooled down to 30° yeast was added, and the fermentation finished in twenty-four hours. By distillation there were obtained 26.5 litres of alcohol of 50 per cent at 15°, quite free from any smell of turpentine, and of excellent taste. It appears that the preparation of alcohol

from sawdust may be successfully carried on industrially when it is precisely ascertained what degree of dilution of acid is required and how long the liquid has to be boiled. When all the cellulose present in sawdust might be converted into sugar, 50 kilogrammes of the former substance would yield, after fermentation, 12 litres of alcohol at 50 per cent.—M. ZETTERLUND.

A NEW PYROMETER.

PROFESSOR A. MEYER, of the Stevens Institute, has made public some interesting and original researches, having in view the determination of high degrees of temperature in furnaces by means of air vibrations produced by sound. The waves of sound are transmitted with less velocity in proportion as air is heated. The proposed practical application is to place a tube in the furnace, and when the tube is thoroughly heated, send through it an organ note. The vibrations of air thus transmitted are made to operate upon a flame indicator, and the difference between the number of vibrations thus shown, when compared with the number of vibrations made by the same note on air at the normal temperature, indicates the heat of the furnace. This is a novel and promising branch of investigation.

SILVERING OF GLASS.

DR. BOTHE.—Ingredients and apparatus required—Sal-Seignette, (tartrate of potassa and soda,) solution of that salt in water, 1 grm. to 50 of water; of ammonia liquida, 50 c.c.; solution of nitrate of silver, 1:8; glass flasks of 1000 c.c. cubic capacity for the reduction fluid, and a like flask for the silvering fluid. Reduction fluid—Mix with 900 c.c. of pure distilled water, 90 c.c. of the above-mentioned solution of the Seignette salt; pour this liquid into the glass flask, and let it boil violently; while thus boiling add 20 c.c. of the solution of nitrate of silver, and continue the boiling for some ten minutes longer; this fluid, which now contains oxytartrate of oxide of silver, can be kept for any length of time, and improves on keeping; if left in the flask, which for convenience should be labelled (1), the liquid has to be filtered before use through filtering-paper. The silvering fluid is made in the following manner: Nitrate of silver is first dissolved in distilled water, and next ammonia added until the precipitate at first appearing is again dissolved; the liquid is next filtered, and diluted with so much water that 1 grm. of the silver salt makes 100 c.c. of solution. For the purpose of silvering, equal quantities by bulk of the fluids

alluded to are first each separately filtered, and next poured together into a vessel of suitable size and shape, wherein the glass plate to be silvered is then placed; this glass should be first scrupulously cleaned.

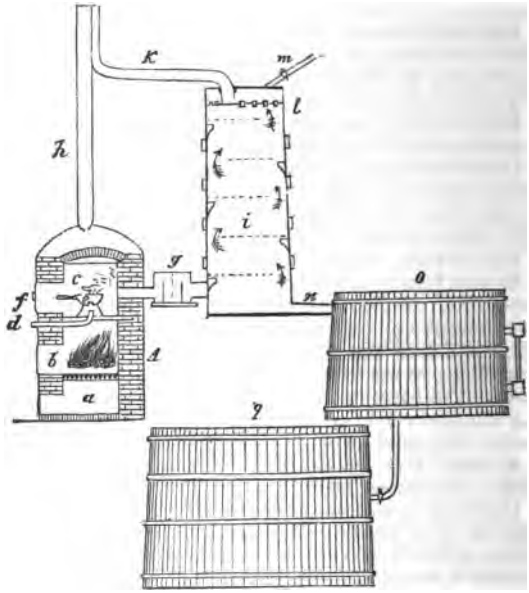
SULPHUROUS ACID IN DISTILLING.

THE discovery that mashes, especially mashes of Indian corn, rye, and wheat, yield more alcohol when treated with sulphurous acid than when merely treated in the ordinary way, is due to the brothers Fleischmann, of Olmutz, Austria, and was made in 1860. The starch granules in the grain are, as is well known, inclosed in integuments which are only partially broken by grinding, so that only part of the amylum is thus exposed. In order to overcome this difficulty, it has been suggested to steep the flour in water. However, it was found that steeped flour soon becomes sour, especially in warm weather, so that, in the process of mashing, less sugar was formed than heretofore. Here the preserving quality of sulphurous acid suggested itself. It was found that it acts by dissolving the husky coverings of the granules, and that it alters the fermentation of the corn in such a manner that the mashes never flow over in fermentation. Moreover, the formation of lactic and acetic acid, which always causes a loss of alcohol, is entirely prevented by the use of sulphurous acid gas. And, what is also an important item, the gyle-tun need not be so constantly scoured and washed. Sulphurous acid gas is readily absorbed by water, which accordingly increases in specific gravity, so that its strength may be determined by the saccharometer. Formerly sulphurous acid was produced by heating a mixture of charcoal and oil of vitriol. The latter loses thereby part of its oxygen, which combines with the carbon, while sulphurous acid escapes in a gaseous form. When used in distilleries, it was prepared in a vessel lined with lead, and conducted into the contents of the mash-tun; but, as the process was expensive and troublesome, it was suggested that the gas be produced by burning roll-sulphur and passing the smoke into water.

In the *Practische Maschinen-Constructeur*, L. Krupski mentions an apparatus which is used for this purpose, of which the following is a description:

A is a brick or cast-iron furnace, consisting of three compartments; *a* the ash-pit, and *b* the fire-place, covered with a cast-iron plate; *c* has a hearth on which the vessel containing the sulphur is placed, all being provided with suitable doors. There is a bent cast-iron pipe *d* passing through the wall of the furnace and the hearth-plate. In

compartment *c* there is a flat cast-iron pot, with a socket in its centre. Pipe *d* and socket *e* serve to carry air into the burning sulphur. Moreover, the door is provided with a two-inch air-hole *f*, with a slide to regulate the access of air. This compartment is arched over with



USE OF SULPHUROUS ACID IN DISTILLERIES.

brick. The smoke ascends through *h*. From *c* the sulphurous vapors pass into compartment *g*, which is divided into four divisions by cast-iron plates, so that the sublimed sulphur may deposit itself instead of being carried over into tower *i*. From *g* the gas passes into tower *i*, consisting of five compartments, formed by perforated projections, which may either consist of wood, cast-iron, or sheet lead. These projections are placed alternately on either side, but there is room left for the sulphurous vapors, which escape through pipe *k*. In each compartment of the tower *i* there are windows four inches square, opposite each other. They serve for the purpose that the ascending of the gas may be observed. In the top compartment there is a division *l*, which is provided

with holes of the size of goose quills, in each of which a pointed stopper is inserted. The space formed by the division *l* serves for the reception of the water, which passes through pipe *m*. The stoppers serve to regulate the influx into the tower; but this arrangement may also be replaced by a rose.

The operation is commenced by placing the necessary quantity of sulphur in pot *c*; the fire is now lighted, and the sulphur is liquefied and inflamed. From the bottom of the column or tower *i*, pipe *n* leads into reservoir *o*, which is provided with a gage, and thence the water impregnated with the sulphurous vapors flows into the gyle-tun *q*. The tower or column is eight feet high and two and a half feet wide; the distances between the projections are one and a quarter feet, with the exception of the division *l*, the distance of which from the cover is only three quarters of a foot. The tower consists of pine-wood staves, and is wider at the bottom. The height to which the vapors have ascended in the tower, after the sulphur is lighted, may be recognized by looking through a window and holding a light before the opposite one; in this case a nebulous light will be noticed. The flow of water may be regulated, by loosening the stoppers more or less, and its quantity may be ascertained by the glass gage of the reservoir *o*. For one and a half pounds of sulphur 200 quarts should be let in, and the flow should take ten minutes' time. If the sulphur is consumed, a new portion is placed in the pot, but in the mean time the stop-cock of the pipe *m* is closed. For 5340 pounds of wheat flour about five pounds of roll sulphur are required. Indian corn requires one third more, but one pound is sufficient for 540 pounds of potatoes. Rye or wheat malt are steeped while the sulphurous water is cold, covered, and left for twelve hours; then steam is introduced, and the mashing machine is set in motion. Indian corn requires twenty-four hours' steeping, but potatoes may be mashed at once. It is proper to retain from potato mashes a portion of the sulphurous water for the cooling vat. Indian corn will yield 20 per cent, rye and wheat 15 per cent, and potatoes 10 per cent, more alcohol if treated by the process above described.

HOSE-PIPE TELEGRAPH.—W. H. Mumler suggests that an electric cable be placed inside of each length of hose, provided with suitable couplings at the joints and a circuit-breaker at the nozzle, so that the hoseman can signal to the engineer to start or stop by means of a dial-telegraph on the engine.

BONES AND THEIR PRODUCTS.

BONES are composed of half their weight of phosphate of lime, about a third of their weight of cartilage or gelatin, and the remainder of earthy matters. The gelatin is extracted by boiling water under pressure, and is used to stiffen calico, etc.; when purified, it constitutes the nutritious aliment known as calf's-foot jelly.

When the bones are heated without access of air, the organic matter of the cartilage is decomposed, oily products passing over, and a black carbonaceous residue being left; this is boneblack or animal charcoal, greatly used as a deodorizer and disinfectant. Bones, when calcined and heated with sulphuric acid, yield super-phosphate of lime, so highly esteemed as a manure. The last, and certainly the most important, application of bones is the manufacture of phosphorus. The bones are first burnt, to remove all traces of animal matter; the resulting bone-earth, as it is then called, is then subjected to the action of sulphuric acid, by which superphosphate of lime is produced. This acid phosphate is then mixed with charcoal, and strongly heated in a retort, when it splits up into normal phosphate and phosphoric acid, the latter by being finally reduced by the charcoal to phosphorus, while hydrogen and carbonic oxide are liberated as gases. The combustible and poisonous properties of phosphorus make it very dangerous to employ in the arts; but Professor Schroeter discovered that when ordinary phosphorus was heated for some time in a closed vessel to a temperature of 470°, it lost its power of igniting spontaneously, and became of a deep-red color. By making use of this discovery, matches can now be made without danger, either to those who manufacture them or to those who use them. The safety-match is made by putting the oxidizing material alone on the match, the red phosphorus being mixed with emery and pasted on the side of the box.

CERESINE.

CERESINE is a new product destined to play an important part as a lighting material. It is obtained from ozokerit or fossil wax by the following process: Ozokerit is heated up to a temperature ranging from 250° to 3000 Cent., in order to separate, by volatilization and subsequent condensation, the liquid oils. The mass being cooled down to 60°, it is heated with from 10 to 20 per cent of the sulphuric acid of Nordhausen. The temperature is then raised to 100°, and care is taken to maintain this heat until the precipitation of the carbon takes place and forms a viscous residue, which is carefully separated from the

supernatant oils, heated, and then treated with about ten per cent of diluted sulphuric acid, afterwards neutralized by aid of an alkali. The mass is then heated to about 180°, poured upon plates and pressed through linen cloths in order to separate the greasy matters; this residue of wax can then be melted and filtered. The product is ceresine, which is employed in the manufacture of candles.

TESTING ETHER.

IT is often very important that photographers should possess a ready means of testing their ether to ascertain if it be free from both water and alcohol. The following method of effecting this has been published in some of the continental chemical journals: Place the ether in a bottle and add to it an equal volume of sulphide of carbon, shaking them well up. If the fluid become milky, it is an indication that water is present; if, on the contrary, the mixture remain clear, then the ether is quite free from water. To ascertain whether the ether contains alcohol, place in it a piece of caustic potash (dry) and allow it to remain for twenty-four hours, when, if there be alcohol present, it will become coated with yellowish-colored matter.

ETHER GLUE.

DR. J. M. MAISCH.—An excellent liquid glue is made by dissolving glue in nitric ether; this fluid will only dissolve a certain amount of glue, consequently the solution can not be made too thick. The glue solution obtained has about the consistency of molasses, and is doubly as tenacious as that made with hot water. If a few pieces of caoutchouc, cut into scraps the size of buckshot, be added, and the solution be allowed to stand a few days, being frequently stirred, it will be all the better, and will resist dampness twice as well as glue made with water.

AMMONIA SHELLAC CEMENT.

As rubber plates and rings are nowadays used almost exclusively for making connections between steam and other pipes and apparatus, much annoyance is often experienced by the impossibility or imperfection of an air-tight connection. This is obviated entirely by employing a cement which fastens alike well to the rubber and to the metal or wood. Such cement is prepared by a solution of shellac in ammonia. This is best made by soaking pulverized gum-shellac in ten times its weight of strong ammonia, when a slimy mass is obtained which, in three to four weeks, will become liquid without the use of hot water. This softens the rubber, and becomes, after volatilization of the ammonia, hard and impermeable to gases and fluids.

ANTI-COMBUSTION SUBSTANCES.

A. PATERA.—While highly approving of the use of tungstate of soda, the author yet thinks there may be substituted for it a cheaper material, namely, a mixture of four parts of borax and three parts of sulphate of magnesia; these salts are mixed together just before being required, (otherwise insoluble borate of magnesia is formed too early,) and then dissolved in from 20 to 30 parts of warm water, in which the fabrics are to be immersed, next wrung out, and then dried. A mixture of sulphate of ammonia and gypsum may be used for coarse fabrics.

SUINT.

IN nothing is the spirit of the age more clearly shown than in the efforts made to utilize waste substances. This is being done with such effect that what was formerly got rid of with great difficulty and at considerable expense, may become one of the most important objects of manufacture. We need only point to such matters as sewage, the slag of furnaces, the fine coal of commerce, the waste of pyrites used in the manufacture of sulphuric acid, etc., as illustrations. Quite a recent instance of this improved economy is found in the treatment of the wool of sheep. It has been ascertained that sheep derive from the soil upon which they pasture a considerable amount of potash, which, after it has circulated in the blood, is excreted from the skin with the sweat, and remains, generally in connection with this, attached to the wool. Chevreuil discovered, some time ago, that this peculiar mixture, known by the French as suint, constitutes not less than one third the weight of the raw merino fleece, from which it is easily removed by immersion in cold water. In ordinary wools the suint is less, the amount being about 15 per cent of the raw fleece. Formerly it was considered as a kind of soap, mainly for the reason that the wool, besides this, sometimes contained about 8 per cent, or a not inconsiderable quantity of fat. This fat, however, is usually combined with earthy matters, mostly with lime, and consequently forms a soap which is very insoluble. The soluble suint is a neutral salt arising from the combination of potash with a peculiar animal acid, of which little more is known than that it contains saltpetre. Special effort has lately been directed to suint, in order to obtain as much as possible of the potash eliminated from the animal, and a special industry has been established in various portions of the great French wool districts, such as Rheims, El Bœuf, etc.

A company purchases from the wool-raiser the solution

of the suint obtained by rinsing the wool in cold water, the price paid for it being higher in proportion as it is more concentrated. As a general thing it is maintained that a fleece weighing nine pounds contains about twenty ounces of suint, which should contain about one third part, or six to seven ounces, of potash, although not more than five and one half ounces are, perhaps, directly available.

In the wool manufactories of the towns just referred to there are nearly 60,000,000 pounds of wool washed annually, the yield of about 6,750,000 sheep. This quantity should contain over 3,000,000 pounds of pure potash. Thus, the water in which the wool is washed, and which has been heretofore thrown away, is made to yield a product, adding appreciably to the value of the wool itself, and more than covering the cost of its treatment. It is, of course, not an easy matter to utilize this solution of suint on a small scale; but wherever the work is carried on by the wholesale, as it is in connection with all great manufacturing establishments, it will undoubtedly become a regular part of the process of manufacture.

SILK-GROWING IN SYRIA.

THE principal productions of Syria available for export are silk, cotton, wool, oil, sesame-seed, millet-seed, Indian corn, wheat, barley, tobacco, madders, sponges, fruits, etc. They are exported from the ports of Latakia, Tripoli, Beyrout, Sidon, Tyre, Acre, Caiffa, and Jaffa. The falling off apparent in the year 1870–71 is due to deficient harvests, and the stoppage of the ordinary export trade of silk to France in consequence of the war. According to the report made by Vice-Consul Jago upon the commerce and agriculture of the Velayet of Syria, this article is cultivated chiefly in Mount Lebanon, the plain of Beyrout and Tripoli. A small quantity is also produced in the Latakia, Sidon, and other districts. The average production of cocoons is estimated at 1,600,000 to 20,000,000 okes, valued between £500,000 and £600,000. The silk year lasts, in ordinary times, ten months, from June to the end of April. It, however, depends upon two things, namely, prosperity in France on the one side, and on the other an abundant crop in Syria, permitting purchases to be made at advantageous prices. The duration of the spinning averages from eight and a half to nine months. The factories give employment to numbers of persons of every age, sex, and religion; and it is estimated that above £40,000 are annually expended in wages in Mount Lebanon alone.

BLEACHING.

INSTEAD of placing in a close chamber, where the materials to be bleached were deposited, the ordinary chafing-dishes full of burning sulphur, M. Bastaert produces combustion in a receiver placed on the grate of a furnace, and covered with a hood. The air required for feeding the furnace comes in beneath the grate by openings made in the side of the ash-pit, traverses this grate, become saturated with sulphurous vapors and rises in the uptake, formed of a sheet-iron tube. This tube is closed on top, and is intersected horizontally by another tube of the same diameter, in the centre of which is placed a steam jet. The jet draws with it the air charged with sulphuric acid, and projects it into the chamber in which are placed the threads or fabrics to be blanched.

The expense of the steam in this process is more than counterbalanced by the economy in time obtained, the operation taking only three instead of twelve hours. It seems, besides, that the properties of sulphurous acid gas, without being changed, are intensified by the presence of the steam, which renders them more penetrating. The ventilation of the sulphur chamber can be also effected more rapidly, when the workmen desire to obtain access to it, for, by using the jet, air can be drawn in great abundance. The manipulation is very simple, depending entirely upon one steam-cock, and the process may be rendered more economical by utilizing the sulphur after it has passed through the apparatus.

A NEW ANTIMONY BLUE.

THIS new color, at once very beautiful and durable, is easily prepared by dissolving metallic antimony in aqua regia, filtering the solution through ground glass, and adding it to a dilute solution of potassium ferrocyanide as long as a precipitate falls. This blue is scarcely to be distinguished from ultramarine, and is a valuable acquisition for flower manufacturers. It can not be employed in contact with lime. Mixed with chrome or zinc-yellow (zinc chromate) it yields a green little inferior to "Schweinfurt green," and is much less poisonous than the arsenic color. (36)

BOLETUS BLUE.

BY T. L. PHIPSON.—The intense blue color produced by the addition of calcium hypochlorite to an alcoholic solution of the yellowish coloring matter of *Boletus luridus*, etc.; and the blue tint assumed by a freshly cut surface of *Boletus* when exposed to the air is, in the author's opinion, to be attributed to the oxidation of aniline naturally present in the tissues of these fungi. The supposition is

based upon the similarity of the color developed in the following reaction:

A small quantity of phenol is dissolved in methyl alcohol saturated with ammonia, and calcium hypochlorate is cautiously added until a blue color is produced. The diluted aqueous solution of the color, when acidified by hydrochloric acid, first assumes a reddish tint, then gradually deposits a resinous substance and becomes yellow. This yellow solution, in presence of ammonia, takes a blue color in a very few minutes by exposure to the air.

The color thus artificially prepared is very similar in tint to that produced by the oxidation of the extractive of several species of the above-mentioned fungi.

PILE FABRICS.

IN pile carpets having the loops held down upon the top of the stuffing-warp by the upper filling-thread or shoot of weft only, the pile or color warp may be easily pulled out and the design thus spoiled by any point accidentally catching on it—as in the use of carpet-stretchers, or a projecting nail of a boot. To obviate this, George Crompton proposes to weave this style of fabric in such a manner that the color-warp shall be securely fastened in by passing it over the upper shoots and beneath the under shoots, being thus so fastened and interlocked with both as to render it almost impossible to draw it up or ravel it beyond the next loop.

NEW PROCESS OF BLEACHING.

MM. SAMAL AND BEROUSON have recently patented, says the *Chronique de l'Industrie*, a new method of bleaching animal textile fabrics by means of a feeble solution of the sulphurets of sodium and potassium. These products act in a remarkable manner in removing the gum in preparing silk and in scouring wool. In practice, in the first case, the bath should be boiling; in the second, the temperature of the alkaline sulphuret should not exceed 50° C. The more difficult it may be to remove the gum and prepare the silk, the less the solution should be sulphureted; in some instances the protosulphuret may be employed. The inventors have also used in the same manner the aluminates of soda and potash.

ARTIFICIAL INDIGO.

BY a scientific investigation, which, for difficulty and complexity, is almost unequaled, says Professor E. Davies, the coloring matter of indigo, indigotine, has been added to the list of natural products now made artificially. Nitroacetophenon, obtained by the action of nitric acid on

acetophenon, itself a product from the dry distillation of benzoates and acetates mixed, only differs from indigotine by H^2O and O. By heating with soda, lime, and zinc, small quantities of indigotine are produced. The process is in no sense commercial; but neither was that by which alizarine was first produced. The way being pointed out, probably improvements will be introduced, and indigo become a product of our own country. Benzoic acid is now made in quantity from naphthaline, a product of coal-tar; so the new coloring matter is related to that exhaustless store of valuable chemical treasures.

SILICATE PAINT.

AN extremely curious local deposit of almost pure silica was recently discovered in one of the hills in North-Wales. The deposit lies in a basin of volcanic origin, at a considerable level above the sea, and forms the bed of a small lake about 2 miles in length and 1 mile in width. The silica bed has a thickness of several feet, and overlies a second deposit of greater thickness, but of less purity. The analytical chemists speak of the material as a great natural curiosity, and Professor Flageolet, of Paris, presents the following analysis:

	Parts.
Silex	79
Water	13
Oxide of iron	3
Alumina	4
Magnesium	1
	100

He states that, so far as his experience extends, the material is unique, and points out that it possesses a wide range of usefulness in the arts and manufactures. Thus it would be especially suited for producing crystal glass, and in the manufacture of porcelain, especially if the small percentage of oxide of iron were removed from it. Again, the chemists of the Liverpool Assay Office report that they consider this earth as the most peculiar and interesting material that has come under their notice, and they agree in stating that it is almost pure silica thoroughly calcined, and reduced to such an impalpable powder as to be, without further treatment, fit to be employed in many ways.

The material, when excavated, is freely washed in water, which holds it in partial suspension, and is then allowed to dry, when it becomes brilliantly white, and is more finely divided than could be done by any mechanical means.

At present the only use made of this silica is in the production of paint. For this purpose it is especially suitable,

as it mixes freely with the pigments and oils, and is worked with the greatest ease. Moreover, it entirely resists the action of any acid, and withstands the effect of heat. Added to these advantages are those no less important, that the paint has no metallic base in its composition, and that when laid on, it becomes extremely hard, and polished on the surface; and it will be understood that, were there no other purposes to which this curious material could be devoted, the manufacture of paint, comprising the advantages mentioned above, is no small matter. The proprietors of this deposit have for some little time past been producing this paint at the works of the Silicate Paint Company, Fenwick street, Liverpool, and extended trials have been obtained with it.

Among others, the Trinity Board of Hull, the Austrian Lloyds of Trieste, the Admiralty, and the Millwall Dock Engineering Company are using it extensively. But although this is one of the most obvious uses to which the almost inexhaustible supply of silica can be put, there remain many others, and we think there can be little doubt that before long an extended use will be found for it in numerous industries. (28)

BRUSH-MACHINE.

AMONG the new machines that have attracted public attention during the past year is that of the Woodbury Brush-Machine Co., of New-York. The mechanism turns out perfect brushes with amazing rapidity, and is distinguished not only for the ingenuity of its parts, but for the superior excellence of its production. At the recent exhibition of the American Institute, in this city, the practical workings of this mechanism attracted great attention.

GAS-METERS.

WET gas-meters are the most convenient and generally used in France, but for many years the introduction of dry meters has been attempted.

The comparative merits of both systems have been often discussed; one thing is certain, that neither assures a perfect registration. The opponents of wet meters argue that the water-level should be kept constant, and that the meters must be periodically filled. If too much water is introduced, the flow of gas is checked, and by letting these become too dry the gas does not flow at all.

Between these two limits, moreover, the meters work only between 3 and 5 per cent of the consumption. On the other hand, it is argued against the dry meters that their action is irregular, and that still greater uncertainty

is inseparable from them than is found with the wet meters.

The Parisian Gas Company has undertaken a series of comparative experiments on both classes of meter. At the conclusion of these trials, which have lasted over several years, the company applied to the municipal authorities of the city definitively to suppress the use of the dry meter.

This demand has been complied with, and the Prefect of the Seine has recently issued a decree forbidding the employment of dry meters among the gas consumers of the city.

PRESERVATION OF MEAT.

By H. ENDEMANN, PH.D.—One of the most rational processes of modern invention is the preservation of meat by inclosing it in air-tight cans. This process would undoubtedly give full satisfaction, if it were not for the mechanical difficulties, which can not as yet be surmounted. If properly carried out, however, it is the best process known, because it furnishes the meat in its pure and unadulterated state, the great agent of decomposition, atmospheric air, being excluded.

When we come to consider the different agents of decomposition, we find that they are, first, the atmospheric air with its myriad germs and spores, and, secondly, water. No decomposition is possible without the latter, and I propose, therefore, the following method of preservation: The meat, after having been cut in slices, should be dried in a hot-air chamber, at a temperature below 140° F. If the apparatus is well constructed the drying may be completed within three hours, if filtered air be drawn rapidly through the chamber.

In this operation the meat becomes quite hard, and can easily be ground in a mill. It is then in the condition which is best adapted for use. The fibrine and albumen not being coagulated, are able to take up water, and the fibres expand into their natural state.

The powder is of a slight brownish yellow color, has a trifling odor of roast meat, and keeps exceeding well. This proves that the salts contained in the meat are entirely sufficient for its preservation, if the quantity of water keeping them in solution is greatly diminished by evaporation.

Its use is easily understood. For beef soup—two ounces of the powder are boiled for a few minutes with one pint of water and the other usual ingredients. The soup thus prepared will be stronger than that prepared from half a

pound of fresh meat, for a solid piece, even after long boiling, will never permit as thorough extracting as the meat powder.

For solid roast meat dishes, the addition of one egg to a pound of meat-powder, together with the requisite quantity of water, suffices to reunite the separated fibres by means of the coagulating egg-albumen.

The fact that the albumen and fibrine are not coagulated makes it a valuable medicine for consumptives, and in all cases of debility where good nourishment is requisite. It is even more easily digested than raw meat, for the reason that, if it is taken with cold or lukewarm water, the process of swelling will take place in the stomach, where, being surrounded by gastric juice, the latter is absorbed.

This I have tested by actual experiment. Corresponding quantities of raw meat and meat-powder were digested in glass flasks, under the influence of equal quantities of diluted muriatic acid and pepsin, at a temperature of about 110° F. While the contents of the vessel containing the meat-powder, after six hours' treatment, represented a uniform though not quite clear fluid, the vessel containing the raw beef contained yet pieces of the undigested material. A dog was fed for eight days with a daily ration of 5 ounces of meat-powder, corresponding to about 1 pound of fresh meat. The average weight of the discharges from the rectum was about one fourth ounce daily, (dried at 200° F.,) the maximum being 8.5 grms., the minimum 5.2 grms. Microscopical examination did not show even traces of undigested meat-fibre. The only part of the meat found undigested were the relics of the sinews. Pieces of wood, cork, paper, and threads of the carpet formed, besides the mucous membranes and constituents of the bile, the solid part of the excrements. The dog, who had formerly been fed on mixed food, grew very lively during this treatment. His weight at the end of the treatment was 12½ pounds.

As no apparatus in which the temperature could be regulated during the drying of the meat existed, I have been obliged to construct one according to my own ideas.

This apparatus is so constructed that the air is sucked through it by an exhauster moved by steam-power. Two valves, one for hot air, the other for cold air, the air being filtered in both cases through cotton, and both acting under the equal outside pressure, supply the apparatus with pure dry air of a certain temperature, which is regulated by the aid of a thermometer. An apparatus of this kind is in operation at my laboratory.

The drying-room of this apparatus measures 27 cubic feet. The air is heated by steam-pipes carrying 60 lbs.

pressure and having 27 square feet heating surface. The exhauster is an inverted quadruple fan-blower of the Rahway Manufacturing Company, of Rahway, N. J., and removes by 420 revolutions 25 cubic feet of air per minute.

By increasing the heating surface and using a larger exhauster, the apparatus may be made more effective yet, so that 100 lbs. of beef can be easily dried within three or four hours. (23)

NEW STUFFING FOR CUSHIONS.

A MATERIAL which has come quite extensively into use in Germany, as a substitute for hair in the stuffing of saddles, etc., consists of a mixture of flax-seed and tallow. The advantage of this substitute consists primarily in the fact that the mobility of the seeds, one upon the other, prevents the packing or settling in any particular place, as often happens in saddles stuffed with hair, thus causing any given pressure to be readily and uniformly distributed over any given surface. The tallow serves the purpose, too, of keeping the leather flexible, and of preventing the absorption of perspiration, protects the article itself, and prevents the back of the animal from becoming galled. Animals with sores or galled spots on the back can be ridden with saddles stuffed with this material without any great inconvenience. The tallow also has the effect of preventing the rotting of the flax seed, and is to be added in sufficient quantity to give the requisite softness to the entire mass. An aromatic odor can be imparted by introducing oil of turpentine or camphor-powder, and the durability considerably increased thereby. One part of tallow to from six to ten parts of flax-seed may be used, according to the temperature.

NEW ICE-MACHINE.

BY A. MUHL, of San Antonio, Texas.—The apparatus is of the class in which volatile fluids, such as ether, are used for the freezing liquid, and in which the vaporized ether is again liquefied by means of condensation and pressure through pumps, and the improvements made are of a character to insure a ready, sure, and economical reduction of the vapor to a liquid state before it is allowed to reach the freezing vessels.

The general operation may be described in a few words. Each pump, as its piston rises, draws in from the freezing vessels the ether which has been vaporized by the heat abstracted from the water or other liquids contained in them; as its piston descends, the vapor of the ether is forced into the worm of the condenser, and thence into a reservoir, into which it falls in a liquid state; it then

passes into the freezing vessels, where it is reconverted into vapor, and from them back into the pumps.

The inventor uses, in this machine, a worm composed of pipes of several different sizes. Several coils of the large pipe, say of one inch and a half diameter, are used at the point of entry, and are followed by coils of inch, half inch, and quarter-inch, by the last of which the exit is made. By this means no resistance is offered to the passage of the vapor at its commencement, and all parts of its body are afterward brought sufficiently near the sides of the pipe to insure its condensation before the reservoir is entered. Thus power is saved, and the full effect of the freezing apparatus developed. The machine has been in successful operation in Texas for a considerable time.

NEW SPOOL LATHE.

THIS mechanism, it is stated, saves not less than two thirds the cost of the old manufacture. It is adjustable in every way required to make articles of various lengths and diameters, and, besides spool-blanks and boxes, any cylindrical goods may be made by it which are sufficiently well finished by the saw at the ends. Among the advantages claimed for it are: the correctness with which it does its work; its ability of using up lumber of any length to within a very short distance from the end—say, one quarter inch—and also of making perfect work from crooked lumber. It can be run by a boy. The machines, as made, are geared for different speeds, and produce from 150 to 175 gross of spool-blanks per day. They are in operation at the spool manufactory of Holt & Hawkins, Salisbury, Vt.

FRICTION MATCHES.

To prevent matches from smouldering after the flame is extinguished, and thus causing accidents from contact with ignitable materials, Henry Howse suggests that the splints be saturated in alum, sulphate of magnesia, tungstate and silicate of soda, borate, chloride, sulphate, and phosphate of ammonia, sulphate of zinc, or other materials which have the property of preventing the splints remaining at a red heat. The igniting composition should also have a portion of one of the above ingredients mixed therewith. A match so made will ignite and burn as readily as the common match, but as soon as the flame is extinguished it becomes instantly black, and does not smoulder.

WELDING IRON PIPES.—In closing up the ends of pipes by welding, it usually takes two "heats" to finish the operation, but J. Doyle states that by causing a blast to act on the end of the pipe during the process, he can close it at one heat.

THE AUTOMATIC TAPER LAMP.

OUR sketch shows a novelty in the form of taper lamps for the instantaneous production of a flame or light, which is accomplished by simply pressing together the two handles shown in the upper figure. The interior mechanism is shown in the figures below. Each tube consists of a little ball of fatty material from which protrudes a short match. These tapers are all set on a rotating plate, under the lamp-cover, and are so arranged that when the handles are pressed together the plate rotates, and one of the matches rubs against the inside of the case near the spout or opening in the cover, which rubbing or friction ignites the match and communicates fire to the ball, which thereupon burns, producing a light that lasts from five to seven minutes. This is a very curious as well as useful little example of mechanism.

PAPERING HOUSES,

IT has been suggested by O. C. Dodge, that frame houses may be rendered cooler in summer, and warmer in winter, by using "building paper" between the sheathing and plastering, placing the paper inside of one stud and outside the next, so that the space between the two will be crossed diagonally by the paper, thereby joining two air-chambers between the siding and plastering at a very slight expense.

RESTORING WASTE RUBBER.—Among the recent patent extensions is that of Baschnagel's patent of 1858, for restoring waste vulcanized rubber. The invention consists in subjecting the old rubber to a heat of from 150° to 600° F., either with or without immersion in water or other cooling liquid. This process so restores the qualities of the gum that it can be used again in the manufacture of rubber goods.

ELECTROTYPE.

By Prof. Heeren.—The employment of graphite with gypsum and gutta-percha moulds causes much trouble and loss of time, because the graphite must be rubbed till it assumes a metallic lustre, which, though a matter of no great difficulty with smooth, even surfaces, is very troublesome when irregularities occur. Better results are obtained when the gypsum mould, soaked in wax, is thickly covered over with a mixture of silver nitrate solution supersaturated with ammonia and alcohol, and the mould exposed to the action of sulphureted hydrogen, whereby sulphide of silver is formed, which is a good conductor. The free ammonia in the solution causes it to adhere more readily to the wax, leaving on drying a uniform, unbroken covering of the silver compound.

When a somewhat powerful current from 4 or 5 Daniell's elements is used, the layer of copper quickly diffuses itself over the whole surface, whereas by employing a feebler current, a softer and less friable copper is obtained.

A good method of preparing the solution is as follows: 1 gram of lunar caustic is dissolved in 2 grams of water; 2½ grams of ammonia of sp. gr. 0·960 are added, and then three grams of absolute alcohol. (5)

IMPROVEMENT IN NICKEL-PLATING.

An improved method of nickel-plating has been devised by Mr. Keith, by which he obtains a flexible and tenacious deposit. The deposits at present obtained are so brittle that the articles will not suffer the least bending. The invention consists in adding to the various solutions of nickel, whether formed of single or double salts, materials which by their presence prevent the decomposition of the solution of the plating-bath, and the deposition of oxide of nickel and other impurities upon the articles receiving the coating of nickel. There is added to the solution of nickel one or more salts, either single or double, acid or neutral or associate, formed by the union of organic acids, acetic, citric, and tartaric, with the alkalies and alkaline earths, ammonia, soda, potash, magnesia, or alumina. These additions will, it is asserted, counteract the tendency to decomposition of the solution by action of the electric current. The following bath is said to work well: To 20 gallons of a solution in water of the double sulphate of nickel and ammonia of 7° Baumé, add 1 gallon of a solution of an equal gravity, of neutral tartrate of ammonia in water. Mix well, and the bath will be ready after standing a few hours.

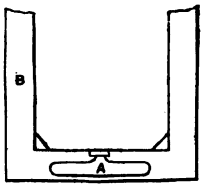


PHOTO-DRIP HOLDER.

AN excellent contrivance for catching the silver drip in large photo-plate holders consists of a horizontal glass bottle A, set into the lower portion of the holder B frame, as shown in the diagram.

PHOTOLITHOGRAPHY.

THE death of Mr. Macpherson, of Rome, recalls an excellent process of photolithography which that gentleman brought to a state of much perfection.

The process in question is based on the insolubility of bitumen after exposure to light—a property in this resin first discovered by the elder Niepce. I shall describe the process as it was worked first by Mr. Macpherson and afterward by myself and many others.

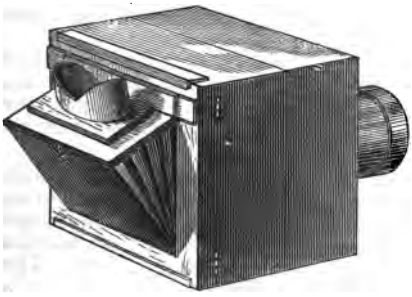
The sensitive material is prepared by placing some small, shining lumps of bitumen in ether and shaking them up for a minute or two. The ether is then poured away and fresh ether added. The bottle containing the ingredients is shaken up for about a quarter of an hour. The ethereal solution is then decanted, filtered, and kept in a bottle for use. It ought to be of a fine transparent brown color.

To use the sensitizing solution, obtain a finely-grained lithographic stone, and having leveled it very carefully, pour the solution of bitumen on the centre, allowing it to flow evenly toward the margin. In doing this, special care must be taken to avoid any currents of air, even from the motion of the arm, for they would cause unequal drying of the film and induce ridges, which are fatal to perfection in the result.

In less than a minute the ether will have evaporated, leaving the stone evenly covered by a thin brown film. The negative is now placed upon the surface and attached to it by strips of paper pasted all round. Thus prepared the stone is exposed to the light, the time necessary being much longer than that required to produce a silver print from the same negative.

The development of the image is a somewhat awkward operation, owing to the weight of the stone, especially if it be a large one. The best way to proceed is to have a flat porcelain bath of a size sufficient to admit the stone, and to pour into it sufficient common methylated ether to cover the bottom of the bath to the depth of half an inch. The stone is immersed in this bath face down-

ward; and, after being allowed to remain for a few seconds, is raised up to an angle of forty-five degrees and moved up and down two or three times. Now suddenly raise it up, turn it over, and wash the surface with a little clean ether. The image will then be seen with all its details, and, after having been allowed to dry, the stone is placed in the hands of the printer, who must etch and treat it as he would a chalk drawing. Bitumen suitable for this purpose is now very plentiful, and is sold at a small price by drysalters in all large towns.—G. MARKHAM, M.D. (I)



IMPROVED CAMERA.

Our sketch shows a very neat little improvement in cameras whereby the use of a cloth is dispensed with, and the trying operation of focusing the picture greatly facilitated. In this improvement the ordinary focusing glass is provided with a bellows, a reflector, and an eyehole as shown. This improvement is the suggestion of B. M. Clinedinst, of Staunton, Va.

A CONVENIENT VARNISH VESSEL is made by using a toy teapot A, and setting a tin funnel C in the top, over which a strip of tin B is placed, covering half of the top of the funnel. In using, pour from the spout and drain the plate into the funnel, in which cotton is placed for filtration.

ELECTROTYPE PLATES.—Mr. C. C. Jordan, whose death recently occurred in England, was supposed to be the first to make electrotype plates and casts in that country. Indeed, it is claimed for him that he was the first in the world to produce such plates, although Professor Jacobi, of St. Petersburg, made them very nearly at the same time, if not coincident with Jordan. The first establishment for the commercial production of electrotypes was that of Mr. Elpington, in London; the same concern still exists, and is conducted on the most extensive scale.

Electrotype plates are now made direct from photo-printing plates, the latter made of gelatin.

MANUFACTURE OF HORSE-NAILS BY MACHINERY.

AT a recent meeting of the London Society of Arts, a paper was read on the above subject by J. A. Huggett, Esq., who said: That part of the horse's hoof into which a nail enters is, as you are aware, a horny substance of different degrees of toughness, some hoofs being exceedingly hard, the common phrase being "as hard as mahogany." Into this hard substance a nail must penetrate under the blows of a hammer, and for this duty the nail must be perfectly rigid and stiff, to prevent any "buckling," which may lame the horse (a not unfrequent occurrence, and against which nature, by some oversight, has not made provision). Now, you probably know that iron possessing these rigid and hard properties is not the iron to stand being bent at sharp angles, its tendency being to break; but it is absolutely necessary that a nail should be bent to a sharp angle, some half inch from the point, to clinch it in the hoof. If this be not done, or if in doing it the nail should crack in the bend, the inevitable result will be that the nail, after it has been at work for a short time, will become loose and drop out. There is also another part of the nail which, though not required to bend, is more frequently the cause of a shoe coming off. You will observe that, where the countersunk of the head terminates, the shank, comparatively slender, begins abruptly at an angle. It is at this part of the nail that the union between the iron shoe and the hoof is effected, and where the nail finds least support surrounding it; and, consequently, where the nail should be the strongest, there in consequence of this angle formed by the countersunk, is the nail's weakest part. But the form of the nail here, as in other parts, is inevitable; the countersunk is to hold the shoe, while the small shank is to penetrate the hoof, and there is nothing short of the very finest description of charcoal iron, worked in the best possible manner, that will stand this test; any thing less than this degree of perfection will result in an imperfect and unsound nail. Enough, it may be said, as to the quality of the nail, but unfortunately, not so; we have not even come to the point, and if ever there was a point of difficulty it is certainly to be found in the point of a horse-nail. A nail with an unsound point, if attempted to be driven, will probably lame a horse; so that if all its other qualities are perfect, the nail unsound at this point is worse than useless it is dangerous, and in the hands of a careless farrier may ruin a horse. It has always been difficult to obtain a sound pointed nail in those made by hand, and hitherto impossible in those

made by machinery. Of the hand-made one in ten proved unsound at the point, while after testing upward of a hundred of our nails we discontinued the experiment, as there was not a single nail of the entire hundred but was perfectly sound. There are three causes that may result in failure to an inventor seeking to produce horse-nails by machinery. One is in some fundamental defects in the principle on which he has constructed his machinery, which, though producing highly satisfactory nails, nevertheless either wears out or knocks itself out in its work; another, that already alluded to, the nails produced being worthless, in consequence of the inability of the inventor to comprehend the qualities so essential in a sound nail; but I should feel favored if, on this occasion, I have permission to state a third, and that is—want of capital.

I will now endeavor to describe the process of making what we call our H. P. horse-nail, from the flat rod of iron until it is ready for the market.

The iron employed we import from Sweden, and it is known as the best Swedish charcoal nail-rods. These rods are flat, being about $\frac{7}{16}$ inch wide by $\frac{1}{8}$ inch thick, according to the size of the nail, and of convenient lengths, about 2 feet 6 inches.

The first process consists in rolling these rods. This rolling is the most important operation as regards the quality of the nail.

The heating of iron for making horse-nails has a most important influence on the quality of the nail. Unsound points in hand-made nails are of frequent occurrence, not from the quality of the iron, nor, indeed, from want of skill in working the iron, but from want of judgment in heating it, the rods being frequently overheated or burnt—not sufficiently, perhaps, to destroy the body of the nail; but when the farrier has to hammer a fine point to the nail for driving, the iron, instead of coming up sharp and sound, becomes rough and spongy, and, under a powerful lens, will appear like a coarse brush, and the nail is said to be hollow pointed. Now, as we have also to heat the rod, it may be fairly asserted that we run the same risks; but this is not the case, and the reason is, that we are able to employ for the heating of our rods a Siemens furnace, so that the iron can not be burnt.

With the exception of the annealing and coloring, this rolling of the rod is the only part of our process in which the iron is worked hot.

The flat rods, six in number, are placed in a Siemens furnace, which is kept at an exceedingly high temperature, and in which the rods are brought to a welding heat in

about 30 seconds. In this state they are withdrawn from the furnace, and tossed in quick succession down an inclined tapering shoot, which communicates with the rolling-mill. The rods slide down, of course, on their flat side, but are required to enter the rolls on their edge. On arriving at the rolls, and about their centre, which they must unerringly strike, they come in contact with the edges of the rolls, which are beveled on the periphery, and by this arrangement the rolls at once turn the rod on its edge, and carry it through the mill at a speed of 1000 feet per minute. The rolling-mill has a solid casting for its base and standards; in these are fitted the bearings, which, you will observe, are of considerable length. Running on these bearings are the shafts of the mill, made of steel ; to these shafts the rolls are fixed by means of keys and nuts; the lower shaft is driven by a coupling attached at one end, the opposite end of both upper and lower shafts having a pinion keyed on, so that the upper shaft is driven by the lower one.

The roll on the lower shaft is perfectly plain, and of a width that exactly corresponds to the roll on the upper shaft; the upper roll, however, has a number of recesses formed at intervals on its surface, which correspond to the bulbs on the rods when they leave the mill, (each bulb or projection afterward becomes the heads of two nails,) also between the recesses on the roll that form these future heads. The space on the surface of the roll produces the shank of the nails, and this space is turned of such an eccentric form that the required taper of the nail from head to point is attained. These rolls are seven inches in diameter, and travel at the rate of 540 revolutions per minute. To assist the iron freely leaving the rolls at all times, a stream of coal-tar is kept constantly running on the rolls, which, falling while the hot rod is passing through, creates a carbonaceous deposit upon the rolls, protecting them thereby from any friction that might be caused by the iron in its transit through, and thus preventing wear, in addition to which, the tar also forms a lubricant between the rolls and flanges, and prevents their heating to any appreciable extent. One ton of rods is rolled in nine hours by two men and three boys. The second machine consists simply of a pair of plain rolls, two feet in diameter, between which rods are passed, that the bulbs or projections, which are now flat, may be reduced to a form nearly square, and somewhat nearer the form required for the head. This machine is worked by two girls. The third machine is the cutting machine. This consists of a frame, through the centre of which

passes a shaft, having at one end driving-pulleys, at the other a slide, which receives a reciprocating motion from a crank-pin on the end of the shaft. By this machine the rod is divided into nail-blanks. The cutters are so arranged that at each descent of the slide two blanks leave the rod. There are two pairs of cutters, one pair dividing the bulb in the centre, thus forming two heads, while, at the same time, the other pair of cutters separate the two shanks at an angle required to produce the tapering point of the nail; and should any slight discrepancy occur in the length of the rods between the heads, so that the shanks would turn out of various lengths, a third pair of cutters descend simultaneously with the other two, and thus removes any excess of length. The machine is worked by a young woman, who cuts 32,000 nail-blanks per day. To remove the scale and rough surface, the nail-blanks are placed in a revolving rumbler, which is nothing more than a plain iron cylinder three feet in diameter, and into which one ton of nail-blanks is placed, and left there until, by mutual friction, they acquire a perfectly smooth surface, and at the same time the point comes into a slight share of improvement, its sharpness being rounded off and smoothed.

Thus clean and smooth, the blanks are passed on to the heading-machine, where the heads are formed into the countersunk shape required. This machine consists of two vertical frames, between which, and near the base, revolves a die-roller; this roller contains twelve pairs of dies, having an intermittent motion communicated by a ratchet-rod connected to an eccentric on the driving-shaft of the machine. In these dies the nail-blank is placed as the roller revolves, and as the dies rise toward their top centre, they are forced together by means of a pair of grippers attached to levers at either side of the machine, and thus the nail-blank, which dropped loosely into the dies, is now firmly held, while the vertical plunger, which contains the heading-punch, descends and forces the head of the nail-blank, which projects some half-inch out of the dies, down into the dies, thus bringing the lump of iron—now about three sixteenths of an inch square, and half an inch long—into a tapering or counter-sunk form. The roller, to enable the top die to perform this operation, waits an instant, and then continues its rotation, and, as the plunger with its top die ascends, the pair of dies in the roller are simultaneously loosened, so that, as the roller revolves, the nails drop from the dies, the dies being loosened by the levers and advanced by the ratchet motion. While this is going on, the dies following are

being supplied with nail-blanks, and so the operation is continued. This machine is also attended by a young woman, who feeds it with 25,000 nails per day.

The headed blanks, in consequence of being pressed cold, are rendered somewhat hard in the head; it is, therefore, necessary, before they enter the next machine, to anneal them in a muffle.

We have now arrived at the last mechanical process, in which the form of nail is finished. This machine is similar in type to the heading-machine last described, its motions being communicated by a shaft passing through bearings at the upper part of two side frames; a cam upon this shaft works a central plunger, the lower part of which contains the top die, and which, being the required form, acts upon the front or face of the nail; there are also two lateral dies which give the nail the required shape on the sides. These dies are fixed in slides, receiving motion by means of levers from arms fixed to the plunger, and acting on the levers by friction rolls. The die forming the back of the nail is a chilled cast-iron table, in which are twelve studs; this table or roller has an intermittent motion, communicated by a ratchet from the driving-shaft at one side of the machine. The headed blanks are placed on the roller with their heads resting against the studs, the roller carrying them forward and bringing them to their position exactly beneath the upper die, where they remain while the plunger descends, and the lateral dies operate on the sides of the blank; these lateral dies, after this their first operation on the side of the blank, now partially retire, while the plunger, with the top die, passing down between them, shapes the nail on its face; then, as the plunger rises, the lateral dies again come forward, pressing the blank a second time on its side, and finishing the shaping as the roller or die-table revolves with a ratchet motion; the nail (for it is no longer a blank) drops by gravity at the opposite side of the machine. Again, this machine, like the others, is worked by a young woman, the daily production being about 21,000 nails. The mechanical operations are now completed, but previously to sending the nails into the market, they require a final tempering and coloring. This is done by heating them in inclosed pots in the annealing muffle, and withdrawing them at a bright red heat, after which they are spread over a large floor, where they are left to cool.

This last operation gives to the nails their proper amount of rigidity, while they retain that perfect ductility they acquired in the first operation at the rolling-mill. It also

produces upon the nails a coating of oxide, termed scale, preventing rust, and gives to them a good color and marketable appearance.

The nail is now completed, and ready for the final pointing, which it is to receive at the hands of the farrier previous to being driven into the horse's hoof.

COMBINING IRON AND STEEL.

A PROCESS for combining iron and steel has been recently invented by Mr. E. Wheeler, of Philadelphia, which consists in bringing the two metals to a welding heat in one "pile," and then subjecting them to a rotary motion. The chief difficulty hitherto experienced in effecting the union has been that, when the steel is subjected to the welding heat of iron, it is injuriously affected by the temperature, and assumes that appearance technically known as "burnt." While the use of proper fluxes may reduce, or even obviate this tendency, their employment is objectionable on several accounts. In Mr. Wheeler's process the combination is effected, and the steel protected from oxidation by being inclosed in an iron case, made as nearly air-tight as possible. The following applications of this invention are proposed: First, the reduction of steel into an iron-coated steel slab, plate, or bar, in which steel predominates; second, the production of steel-centred iron, in which iron is the principal metal used; and third, a combination proper, in which the steel is so proportioned and placed as to endure wear and support strain.

Cast-steel scrap, when incased in iron as described above, can be rolled into finished bar at one operation, and even Bessemer steel scrap, which has hitherto defied every attempt to weld it up into a sound mass, is by this process reworked from any size of "pile" into any desired shape of rail, bar, or plate, as sound and homogeneous as from the original ingot. (39)

IMPROVEMENT IN LEAD FURNACES.

AN improvement of no little merit has been lately made in the construction of lead-smelting furnaces, by which the metal, instead of being "tapped" at stated intervals, is furnished with an automatic tap, the invention of Mr. Arents, of Eureka, Nevada. In the old style of furnace the lead was tapped from the lowest point of the basin, whenever the accumulation of the metal rendered this step necessary. The tap-hole was opened by driving in iron bars by repeated blows of a heavy sledge, by which the whole masonry was jarred; and if the hole happened to be closed with chilled lead, it was a task of no little magnitude to drill through it. Moreover, by drawing off at one time

many hundred pounds of lead, the level of the melted mass in the furnace was suddenly lowered several inches, when the charges would quickly fall into the zone of fusion without being properly prepared, and thus give rise to a large loss of lead in the slag, and to great irregularity in the working of the furnace. Labor and fuel were thus greatly wasted. The invention of Mr. Arents consists simply of a dam outside the furnace, connected with the inside by a tube at the lowest point. The level of the lead remains the same inside and outside; the dam is always kept full, and the lead is ladled out of it nearly constantly. Immediately above the level at which the lead is kept is a tap-hole for matte; at another side of the furnace, and a few inches higher up, is the slag-hole, whence the slag runs in a continuous stream. By this simple arrangement the furnace works on much more regularly and economically than by the old plan. The tuyeres are kept free from the descent of raw ore, while, as a consequence, there is little or no loss of lead in the slag. The lead drains quietly and perfectly through the slag. If any matter is formed, it is drawn off separately; while, as the lead rises into the dam from the very bottom of the furnace, where the purest metal accumulates, it is always as free as possible from foreign materials. (39)

IMPROVED CUPOLA FURNACE.

SMELTING iron in a cupola furnace appears to most people, who see it daily done at every foundry, the simplest thing in the world; it is, however, not so, if due regard is taken to economy and good quality in casting. In a common cylindrical cupola, three essential parts may be distinguished. The upper half or body of the furnace prepares the pig-iron and lime, which, together with coke, are thrown in at the top for smelting in the middle part or crucible, which is somewhat narrower and provided with numerous nozzles for the introduction of blast, whence the molten iron, together with slag, runs down to the lower part, or hearth, where it collects until it is tapped. When such a furnace is to be started, it is filled to about two-thirds with coke and one-third with coke and iron; fire is then introduced and the blast turned on, when the molten iron collects in the hearth and replaces the coke of the same. Here it necessarily takes up impurities from the coke and impregnates the latter so much that it can not be destroyed by the blast; and when the iron is tapped, masses of coke and half-melted iron, which are not any longer supported, tumble down in the hearth where they are imperfectly burnt or melted, and cause the iron

which collects there to become cold and sticky. These irregularities take place after every tap, and it generally happens that iron, which was at first fluid and gray, suddenly becomes thick and white, and unsuitable for the castings intended. In order to avoid this, Henry Krigar, of Berlin, constructs his cupola so that the lower part, or hearth, is not below the crucible, but by its side, and connected with it by a slanting canal, which is about 3 inches high, 6 to 8 inches long, and as wide as the cupola. This arrangement prevents any coke or half-melted iron from falling down in the hearth, which is only accessible to melted iron and slag, and forms for them a kind of sump or receiver, which in no way interferes with the regular working of the two upper parts of the cupola. This very simple construction has proved highly successful, and its great advantages are a saving of fuel, a uniformly hot and liquid iron, and an increased yield per diem, as the regular smelting operation is never interrupted. Kregar's cupola can, therefore, be recommended not only to foundries, but also to Bessemer works, and to such forges as use the Danks puddling furnace with liquid iron, as a uniform heat and quality of each charge are essential for their success. (28)

CAST-IRON-STEEL TOOLS.

BARRON'S process for the manufacture of steel tools—or, rather, for the conversion of iron tools into steel—is now in successful operation in Louisville, Ky., where it has attracted no little attention, and has met with very encouraging success. Tools which are to be prepared by this process are first made of cast-iron, after which they are introduced into a revolving drum, where the roughness and adhering sand from the moulds are worn off by attrition. The smooth irons are then packed in layers in iron boxes, where they are closely embedded in clay, and subjected to the action of oxide of iron and certain chemicals, by which the iron is decarburized. There seems to be a secret connected with this part of the process. In these boxes the iron tools are subjected to an annealing heat, which is maintained for from three to six days. They are subsequently placed in a retort capable of containing about a ton of the tools, into which the vapor of gasolene and other carbonaceous materials are passed. In a few minutes the iron is transformed into steel, when they are ready to be tempered, and ground and polished for the market. The explanations of this process which we have seen are not as clear as they might be, but of the quality of the steel thus produced there is very little question. Professor J. S. Newberry, of the School of Mines, Colum-

bia College, New-York, referring to this subject, says: "With tailors' shears cast in shape, made malleable, and then converted by the Barron process, I have cut Florence silk so nicely as to prove the edge perfect; then, with the same shears, have cut up sheets of tin and untempered steel; returning to the silk have found the edge wholly unimpaired, and this after a repetition of more than twenty times."

MANUFACTURE OF IRON.

A PROCESS for converting cast into wrought-iron, suggested by Pierre Eymard Jay, consists in making a compound of thirteen parts of nitrate of soda, seven parts of oxide of manganese, and four parts of oxide of iron, and adding three pounds of such compound to each hundred of melted cast-iron operated on, and in the employment of a blast of atmospheric air impinging on the surface of the liquid metal during the time it is being subjected to the intense chemical and mechanical action of the ingredients specified. The result is that the sulphur, phosphorus, and arsenic are eliminated along with the carbon, leaving the iron in an approximately pure state, and forming a scum upon the surface of the melted iron, which, upon cooling, becomes scoria, or slag. The function of the blast is mainly to separate or so act on this scum as to enable the sulphur to evaporate freely. By a subsequent process, cast-iron of good quality is produced by melting the slag thus made in a cupola with layers of ore between, and by the use of a blast acting upon the surface of the metal when liquefied.

UTILIZING TIN SCRAPS.

THE following process is stated by Thomas F. Wells to be very economical in the use of acid for removing the tin from scraps: The clippings are inserted in a perforated drum of copper, and are successively dipped and revolved in three tanks—the first of which contains hydrochloric acid, the second water, and the third a weak solution of soluble glass—for dissolving the tin, washing the scraps, and coating them with silicate to prevent oxidation. After the acid has become somewhat exhausted, its strength may be renewed by adding from two to three per cent of nitric acid, and from one to one and a half per cent of chlorate of potash. When the bath has become entirely exhausted, the acid is drawn off and the tin is precipitated by means of zinc, or otherwise. The liquor remaining consists of a solution of the chloride of iron and zinc, which is available for the preparation of paints, or as a disinfectant, or for the preservation of wood.

MALLEABLE CAST IRON.

THE following process of manufacturing malleable cast iron is described by A. H. Siegfried: With each hundred pounds of molten iron add five pounds of a composition made by mixing one pound of concentrated lye, one pound of sal soda, one and a half pound of sulphate of copper, one pound of sal ammoniac, one quarter of sulphate of potash, the same of nitrate of potash, and three and a quarter pounds of common salt. From iron so treated make the required castings, and while yet red hot draw them from the sand and dip them in a bath of one gallon of water, one ounce of each of concentrated lye, sulphate of copper, alum, sal soda, sal ammoniac, eight ounces of common salt, and a half ounce of sulphate of potash. Then anneal from three to eight hours.

PISTON-RODS.

To save the expense of new piston-rods in steam-engines, sometimes rendered necessary by the unequal wear, J. F. Carll proposes to make the rods with sleeves surrounding them, which may be turned occasionally, or entirely renewed at a slight expense, if worn out.

NOVEL ROTARY PUDDLING FURNACE.

ACCORDING to a statement of H. A. V. Post, a rotary puddling-furnace superior to those heretofore used may be built by arranging the basin in which the metal is melted on a shaft set at an angle of about thirty degrees from the perpendicular. This shaft, however, should be so arranged that this angle may be varied to suit circumstances. Mr. Post considers this style to combine the advantages of both varieties of rotary puddling-furnaces without their disadvantages.

METAL PIPES.—Peter Naylor proposes to manufacture pipe of an alloy composed of from ninety-five to ninety-nine parts of lead, and from five to one of antimony, which he claims will make the pipe twice as strong, much more flexible, and of less cost per running foot, because it can be made much lighter. For special purposes, he proposes to use more antimony—as high as ten per cent in some cases.

IRON FURNACES.—As a means of increasing the heat used in reverberatory and other furnaces, W. H. Sellers proposes that they shall be so built as to cause two flames to enter in opposite directions, so that, as they strike each other, a more intense heat will be developed by the thorough mingling of their gases, than can be developed by a single flame.

PROTECTING SAFES ON RAILROAD TRAINS.

To prevent safes from being opened or removed from cars by other than duly authorized persons, S. J. Hoffman proposes to provide them with electric wires connecting with alarms which may be stationed in the engineer's cab or other suitable place. Any attempt to open or remove these safes will cause an alarm by the breaking of the circuit, except by persons having the proper key, which acts on a "switch-lock" that keeps the circuit complete when the door is opened. The doors and windows of the car are also provided with alarms acting on the same principle.

BROWN TINT FOR IRON AND STEEL.

DISSOLVE, in four parts of water, two parts of crystalized chloride of iron, two parts of chloride of antimony and one part of gallic acid, and apply the solution with a sponge or cloth to the article, and dry it in the air. Repeat this any number of times, according to the depth of color which it is desired to produce. Wash with water and dry, and finally rub the articles over with boiled linseed oil. The metal thus receives a brown tint and resists moisture. The chloride of antimony should be as little acid as possible.

ROD OR WIRE SOLDER.—A method of making solder in the form of fine rods or wire, devised by Ferdinand Deming, consists in casting an ingot of round form, which is afterward set revolving in a self-acting lathe, having in place of the ordinary tools one with a point resembling a fine hollow punch, which, as it acts on the ingot, takes off a shaving of the shape of the aperture through the nose of the tool, and of a length proportioned to the spiral described by the tool in passing from one end of the ingot to the other.

CONVERTING CAST-IRON INTO STEEL.—According to a statement of Thomas Clark, tools made of cast-iron may be converted into steel by the following process: The tool is placed in an annealing furnace and heated until about two-thirds of the carbon is removed from the tool, after which it is taken from the furnace, cleaned, and hammered into shape, (straightened,) and about one eighth of an inch cut from the entire edge. The tool is now heated and tempered in the same manner as if made of steel. By this process, it is said that the carbon which was allowed to remain in the tool has been thoroughly scattered or diffused, and the casting converted into steel.

REDUCING LEAD ORES.

A PROCESS devised for simultaneously reducing Galena or lead ore and auriferous pyritous ore, collecting other metals contained therein, such as gold, silver, copper, &c., devised by Messrs. Blaney and Adams, consists in adding to each five hundred pounds of Galena and the same quantity of desulphurized or roasted pyrites, from fifty to seventy-five pounds of coke or charcoal to supply carbon, and from three hundred to five hundred pounds of an alkali such as soda-ash, or an alkaline earth such as limestone or quick-lime, or a mixture of the two. In smelting these ores the sulphides of the various metals present, such as gold, silver, copper, lead, &c., are reduced to the metallic state, and the lead acts as a medium to collect and carry down the metals in both ores. The carbon removes the oxygen from the iron oxides, leaving the metallic iron in a minutely divided state to remove the sulphur, and the soda-ash or lime combines with the silica, alumina, &c., and with any remaining iron that there may be, to form a fusible slag, permitting the reduced metal to settle at the bottom.

GALVANIZING BRASS AND COPPER.

M. BOTTGER states that copper and brass may be coated with metallic zinc in the following way: Finely divided zinc, in a non-metallic vessel, is covered with a concentrated solution of sal-ammoniac; this is heated to boiling, and the articles of copper or brass, properly cleansed, are introduced. A few minutes then suffice to produce a firm and brilliant coating. The requisite fineness of the zinc is produced by pouring the molten metal into a mortar, and triturating it until it solidifies.

A NEW METHOD OF NICKEL-PLATING.

DR. WOLCOTT GIBBS gives, in the *American Journal of Science*, a brief description of a new process for plating various metals with nickel without the use of a battery, which process was devised by Professor Stolba. Into the plating vessel—which may be of porcelain, though the author prefers copper—is placed a concentrated solution of zinc chloride, which is then diluted with from one to two volumes of water, and heated to boiling. (If any precipitate separates, it is to be redissolved by adding a few drops of hydrochloric acid.) As much powdered zinc as can be taken on the point of a knife is thrown in, by which the vessel becomes covered internally with a coating of zinc. The nickel salt—for which purpose either the chloride or sulphate may be used—is then added until

the liquid is distinctly green; and the articles to be plated, previously thoroughly cleaned, are introduecd, together with some zinc fragments. The boiling is continued for fifteen minutes, when the coating of nickel is completed, and the process is finished. The articles are well washed with water and cleaned with chalk. If a thicker coating be desired, the operation may be repeated. Professor Stolba found that copper vessels thus plated were scarcely tarnished after several months' use in the laboratory.

TALMI OR ABYSSINIAN GOLD.

BY DR. C. WINKLER.—The author points out that the alloy is not galvanically gilt, but is plated, that is to say, a very thin sheet of gold is made to adhere to a yellow metal (in 100 parts—copper, 90.74; zinc, 8.33) by rolling tne metals together, and afterward shaping, moulding, and chiseling it by means of steel tools, the amount of gold varying from 1.03 to 0.03 per cent. As regards wear and tear, the author admits that, by careful plating, these articles answer really well.

WATCH-SPRINGS.—A pound weight of the steel wire from which the springs are manufactured will produce about 5000 gross of springs, which are sold generally at $12.50 per gross, thus amounting to $62,000 in value. The springs are only the one-thousandth part of an inch in diameter, and one pound weight of them would extend about nine miles.

UNITING BRASS TO IRON OR STEEL.—It is suggested by G. R. Meneely, that any of the alloys of copper, as brass, bronze, etc., may be united to steel or iron by setting the latter in a mould and running on it at a white heat sufficient of the alloy to bring the harder metal to the welding-point, which will cause a fusion of the particles of the two and unite them.

AN alloy which may serve to solder iron or steel to brass, by C. Mène, consists of 3 parts of tin, 39.5 of copper, and 7.5 of zinc, which latter, since some of it is volatilized by the smelting together of the metals, may be increased to 10 parts.

DRESSING MILL-STONES.—It has been suggested by T. Rogers that much of the time lost in dressing mill-stones might be saved by lowering the runner so that the two faces would touch and then running the mill without grain, thus producing the required sharp corners by grinding the two stones one on the other.

NEW BELL-METAL.

IT is stated by Helen L. Macker that a compound of copper, nickel, zinc, aluminum, and quicksilver, in varying proportions, will make a bell-metal superior to the usual alloy in the following particulars: It will tarnish but very little; produces a better tone; being softer, it is less likely to crack; a bell of this compound of the same size as one of ordinary metal will weigh from twenty-five to fifty per cent less, according to the precise composition used, although costing about the same per pound.

AMERICAN STERLING—A NEW ALLOY.

IN its crude state, this new alloy resembles nickel; but after being worked up, it is almost undistinguishable from silver. Unlike the latter metal, it does not tarnish and is unaffected by sulphurous vapors, so that it is eminently adapted to replace silver, Britannia, or the ordinary alloys in the manufacture of the table ware. Articles of food have no action upon it; alkalies produce a temporary tarnishing, which may be immediately removed by a slight rubbing with the hand. Made in the form of cutlery, the alloy possesses none of the disadvantages of steel or plate; it takes a keen cutting edge, requires little or no cleaning, and is unaffected by ordinary organic acids. Knives made from it show no black edges after short usage, as in the case with plate, while they can be ground or sharpened whenever necessary. The metal is unusually flexible and tenacious; a table fork made from it was, in our presence, twisted into a perfect knot, without showing the least flaw or intimation of breakage.

In the manufacture of hollow ware, there is little doubt but that, when this composition becomes widely known, it will prove a formidable rival to, if it does not entirely supplant, German silver and its kindred alloys. It is not only harder but one third lighter than Britannia metal, while its cost is about one half that of plated ware. Although the articles made from the solid sterling present an appearance equal to fine silver, the alloy may, when required, be used as a basis for electro-plating, the smoothness and evenness of its surface rendering it possible to give the deposited silver a much higher finish than can be imparted to ordinary plate. As the silver wears away in course of time, the sterling, being of the same color, gives no evidence of the fact, so that the unsightly brassy edges and backs common to long used plated table ware are entirely obviated.

The effect of hammering or compression on this composition is to give it an increased elasticity. Its strength is

so great that it can be, and has been, substituted for steel in the manufacture of pistol-barrels, while repeated tests, made at the Colt Armory, at Hartford, Conn., show that it has three times the tenacity of the latter metal. At an experimental trial, a spring of steel wire parted at 3000 pulls: 82,000 pulls were necessary to break a precisely similar wire of sterling.

The American Sterling Company, Leavitt Hunt, Esq., President, has its offices at Nos. 1 and 3 Dey street, in this city. The works are located at Naubuc, near Hartford, Conn., and consist of substantially built brick buildings, 500 feet long and 50 feet wide. About 120 hands are employed, and some $100,000 worth of tools of every description are in use.

PREPARATION OF CHLORIDE OF GOLD.

We have recently had some illustrations of the use that a photographer may make of a pair of little galvanic cells in the preparation of some chemicals, but more particularly in the production of chloride of gold free from all nitrous compounds.

The mode of working is exceedingly simple, and the battery required a small one—in fact, two pairs of the carbon or zinc plates excited by bichromate of potash are sufficient; and, since this particular form of battery may be dismounted or set up at a moment's notice, it is the most convenient for use. The pair of cells, as sold, have the zinc of one joined to the carbon plate of the other; but for our purpose it is rather better to join like plates together. If this be done we get a wire from the carbon plates and another from the zinc plates, and these we may respectively call the carbon and the zinc poles. If, now, we dip the poles formed of copper wire into strong hydrochloric acid, hydrogen gas is evolved at the zinc pole, and the copper forming the other pole dissolves in the acid, which becomes speedily colored, owing to the formation of chloride of copper.

If, instead of copper, we put a slip of gold for the carbon pole, the gold dissolves quietly, forming chloride of gold, hydrogen being evolved from the other pole; but if the latter were allowed to come in contact with the gold the metal would be deposited. In order to avoid this the following plan was adopted:—A small bowl of a clay tobacco pipe was taken, and the outer glazed surface filed off. It was then placed in a little dilute hydrochloric until fully saturated with the liquid. The bowl of the pipe was then nearly filled with the dilute acid, a small wire of platinum fastened in by means of a cork stopper having a notch in

its side in order to allow of the escape of gas. Strong hydrochlorine acid was then placed in a small capsule, and the slip of gold to be dissolved plunged into it, but the gold had previously been placed in connection with the carbon pole by cutting a notch in the copper wire and making the two sides grasp the gold. The latter was then plunged into the strong acid. Next, the platinum wire immersed in the acid liquid contained in the little pipe-bowl was connected with the wire coming from the zinc plate of the little battery, and, when the connections were complete and the cells in action, the bowl was allowed to dip into the strong hydrochloric acid. As the current passed the gold dissolved, and the hydrochloric acid became strongly colored from the resulting chloride of gold. We do not know how long the action was allowed to continue, but the hydrochloric solution of the gold salt was taken after some time and evaporated to nearly dryness, and a considerable product of the pure chloride thus obtained.

We do not know how much of the chloride soaked through the tobacco pipe bowl, but a certain amount of loss must have occurred in this way. (1)

MAKING GAS AND MELTING ORE.

A METHOD of making gas from fine coal-dust, and of using such gas in the reduction of ores for making iron and steel, described by Thomas J. Chubb, consists essentially in dropping finely pulverized coal or coal-dust, slowly and gradually, by mechanical means, into the top of a stack filled with highly heated air or oxygen gas, so that each particle will be submerged and enveloped in it, and by the combustion create a gas which may be used for illuminating, or reducing ore. When used for the latter purpose, the ore should be crushed into fine particles and delivered into a stack filled with gas made as above, in the same manner as the coal-dust, or the dust and ore may both fall into the stack at the same time, and act on each other in conjunction with the intensely heated gases.

COPPER-COATED IRON PIPES.—Henry J. Newton proposes the coating of wrought or cast-iron pipes by first subjecting them to a suitable pickling process in acid, after which they are immersed in a bath of a solution of copper in connection with a galvanic battery, thus forming a coating which will prevent corrosion.

GILDING COMPOUND.—By the use of a compound suggested by A. S. De Vries, consisting of one ounce of gamboge, three ounces of Japan gold-size, and a half ounce of turpentine or benzine, any surface of bright metal may be made to look as if gilded.

NEW GAS-FURNACE.

MADE BY THOMAS FLETCHER, LONDON.—The specialty of this furnace is the burner. It is as simple as an ordinary Bunsen's burner, but the flame is solid to the centre. Copper will fuse in any part of the flame; and to make a crucible furnace simply requires a support for the crucible, and a fire-clay jacket to prevent radiation. The lower part is a chamber 6 inches by 3 inches, open at the bottom, in which the gas is partially mixed with air. This mixture is conducted to the top of the burner through a mass of fine tubes, with an arrangement to supply between each exactly the amount of air necessary to consume it instantly. A flame produced by this means, consuming 20 feet of gas per hour, is about 2 inches high and almost colorless. The whole of the available heat is generated below the object to be heated, which, therefore, is not also cooled by the passage of unburnt gas and air. The point of greatest heat commences, as with a blowpipe, at the point of the blue cones, about $\frac{1}{2}$ inch or $\frac{3}{4}$ above the tubes; and if the flame is protected with a ring of fire-clay, continues uniform for some inches above. The great heating power of the hot-blast blowpipe is obtained by an arrangement which enables both gas and air to be applied to the jet at an exceedingly high temperature. The jet will fuse a strand of 6 or 8 fine platina wires into a bead with a small point of flame, and will give a small light with a cylinder of lime. With the gas fully turned on, it will melt 3 ounces of 18 carat gold on pumice-stone. Steel wire burns readily with brilliant scintillations, and wrought-iron wire is readily fused. The additional heating power may be used or not, at will, and the blowpipe can be used either with the mouth or a foot-blower; when used with the mouth, the head is not confined in one position, as in case of the old form, and both hands are at liberty. The extreme power is exerted to the best advantage on as small objects as possible, and when the gas is turned down to a blue cone of about 1 or $1\frac{1}{2}$ inches long. The point of this blue cone will fuse a few grains of platinum, supported on lime, in five or six seconds, if a foot-blower is used. If, however, a small quantity is taken—say half a grain—it is fused into a bead instantly, either with the mouth or a foot-blower. If a platinum wire is used, it should be held with the point exactly in front of the point of the blue cone. With care a bead may be fused on the end of a platinum wire almost as thick as ordinary copper bell-wire. If a very fine wire is used, it will melt almost as quickly as it can be passed along the flame: in these experiments the eyes should be protected from the blinding glare of light,

more especially in fusions on lime. For soldering and heating platinum crucibles, the gas should be turned full on, so as to produce a large, rough flame, the heating power of which is about double that of the ordinary blowpipe. The lower burners need never be turned on more than is necessary to allow the flame just to reach the top of the coil. A trial of these apparatus in our laboratory, says the editor of the *Chemical News*, has proved them to be most useful; but there is room for great improvement in the workmanship.

MANUFACTURE OF CHLORINE.

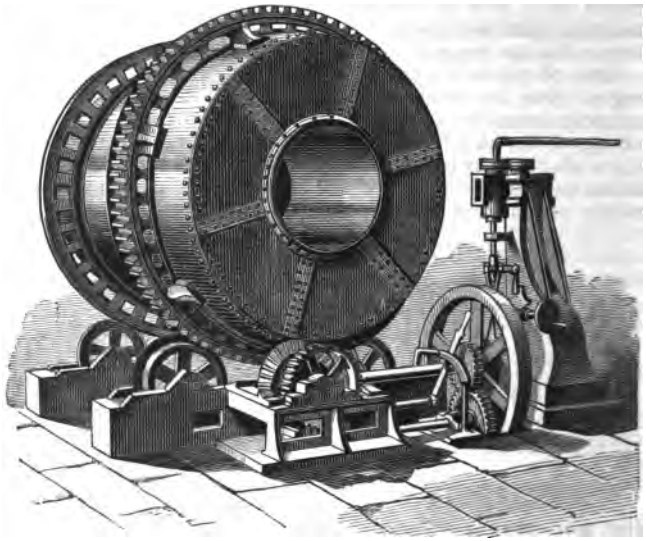
To produce chlorine, S. E. Aubertin causes a mixture of air and gaseous or liquid hydrochloric acid to pass over a sesquioxide of chrome, heated to about 600° F., thus causing the combined oxide of chrome and the oxygen of the air to unite with the hydrochloric acid, thereby producing water and liberating chlorine. In place of the sesquioxide of chlorine, the ore of chromium may be used in its natural state, or the minerals known as chromocre, chromite, etc.

MANUFACTURE OF SULPHUROUS ACID.

A PROCESS for simultaneously producing liquid sulphurous acid and an aqueous solution of the same, devised by Nelson P. Akin, consists chiefly in burning sulphur or pyrites in a chamber under high gaseous pressure, and by such pressure forcing the gaseous products of combustion into a condenser in which high pressure is maintained, then passing the gases not liquefied in the condenser through a bed or column of silicious pebbles or their equivalent, kept wet by water running in at the top of the column or chamber containing such pebbles, and collecting the aqueous solution thus formed in a chamber below a perforated diaphragm supporting the pebbles.

UTILIZING WASTE GASES.

To utilize the gases contained in the products of combustion after being used in furnaces, etc., Brereton Todd proposes to pass them through a "transformer," (a chamber containing carbonaceous matter,) so as to convert the carbonic acid gas into carbonic oxide, and then collect the gases and burn them as fuel. When such products of combustion are mixed with gases or fumes from chemical or other furnaces, after passing through the chamber or "transformer," they are passed through a condenser, and such fumes or vapors condensed to recover the materials therein contained.



MANUFACTURE OF CARBONATE OF SODA.

OUR engraving shows a form of revolving furnace for carrying out this manufacture, introduced by Messrs. Robert Daglish & Co., of St. Helen's Foundry, Lancashire, Eng., and which is now being employed at a number of soda-works with very successful results.

Carbonate of soda is produced from the sulphate, and the first and most important process in the manufacture is to transform the sulphate into the crude form of carbonate or black ash. Under ordinary circumstances this black ash is made by mixing three parts of the sulphate with about three and a half parts of limestone, and about two parts of small coal, and subjecting the mixture to a roasting process. During the roasting the materials are stirred by hand, the process resembling in many respects that of iron-puddling. The charge, originally shoveled into a part of the furnace where it receives a preliminary heating, is first spread evenly upon the hearth, when its surface begins to fuse. After a few minutes, the material is turned over, and eventually, after it has been subjected to the heat for a short time longer, small jets of flame, called by the men "candles," burst out all over the mass. The materials are then well stirred and incorporated, and

eventually, when the jets of flame begin to fade away, the molten mass is drawn off into cast-iron moulds, where it forms blocks known as "black ash balls."

The chemical changes which take place during the roasting process are, some of them, rather complicated, but the principal may be briefly stated as follows: The materials charged consist of sulphate of soda, ($Na\ S\ O_4$,) carbon, (4 C,) and limestone, ($Ca\ C\ O_3$.) On the application of the heat, the carbon, in the first place, effects the deoxidization of the sulphate of soda, the result being the production of sulphide of sodium (Na S) and carbonic oxide, (4 C O,) which latter takes fire, forming the jets of flame already referred to. Next the limestone comes into play, the carbonate of lime and sulphide of sodium decomposing each other, and the result being sulphide of calcium, (Ca S,) and carbonate of soda, ($Na\ C\ O_3$.) Some of the limestone is also changed into caustic lime, and a little caustic soda is also formed; but to these minor changes, as well as to some others due to the fact of the coal used not being pure carbon, and to other causes, we need not further refer, as they do not affect the general result, of which alone it is necessary for us to speak here.

The furnace which we now illustrate does away with the rabbling by hand of which we have above spoken, and it may, in fact, be regarded as occupying the same position with regard to the ordinary hand process that Dank's rotary puddling-furnace does to ordinary hand iron-puddling.

The revolving furnace consists of a cylindrical casing of boiler-plate 10 ft. in diameter by about 15 ft. in length, this casing being lined with fire-brick, and encircled at two points by rails bearing on friction wheels. Near one end also the cylinder carries an annular rack, into which there gears a pinion carried by a short shaft placed as shown. This shaft also carries, running loose upon it, a bevel-wheel and a worm-wheel, and a sliding clutch is fitted between these wheels, so as to drive the shaft by either of them. The bevel-wheel is driven by a bevel-pinion on the end of the engine-shaft, and is used when the furnace is required to revolve quickly, the maximum speed being five to six revolutions per minute. The worm-wheel is driven by a worm on a second motion shaft, this shaft being connected by a pair of spur-wheels to the engine-shaft, and is used when slow speed is required, the minimum speed being about one revolution in twenty minutes; intermediate speeds can be obtained as required by varying the speed of the engine, and the motion can be reversed by reversing the engine, which is fitted with a

link-motion for this purpose, as shown in the engraving. The materials are charged into the cylinder through an opening at the side, fitted with a suitable cover, this opening also serving for the discharge of the "black balls" into wagons arranged to run on a tramway passing beneath the furnace. The wagons are shifted by gearing worked by the engine which drives the furnaces.

At each end of the cylinder is a central opening about 4 ft. 3 in. in diameter, one of these openings communicating with the flue by which the gas used for heating the furnace is conveyed to the latter from the gas-producer, while through the other opening the products of combustion pass off to a furnace containing the "salting-down" pan, the latter being thus heated by what would otherwise be waste heat.

It will be seen, from the description we have given, that the whole arrangement of revolving furnace is very simple, and it is one which does its work efficiently and economically. Messrs. Danglish have now ten of these furnaces at work, and others in course of manufacture.

The "black ash balls" obtained by the above process are broken up and placed in lixiviating vats, in order that the carbonate of soda may be dissolved out of them, and the solution thus obtained is drawn off to be treated by causticizing or salting down; an insoluble "waste," which, in the form of sulphuret, contains nearly the whole of the sulphur present in the "black balls," being left behind. If caustic soda is to be made, the solution just mentioned, or "vat liquor," as it is called, is boiled with caustic lime, when the latter deprives the carbonate of soda of its carbonic acid, leaving it in solution in a state of hydrate. This solution is concentrated and boiled down, and the caustic soda thus obtained is packed in iron drums, or run on to plates to be broken up.

The alternative treatment of the "vat liquor" consists in boiling it down until it is converted into a mass of gray crystals known as "salts," these "salts" being subsequently subjected to a calcining process, which volatilizes any sulphur present, and carbonates any alkali which is in a state of hydrate, the result ultimately being a white product known as soda ash. To obtain soda in crystals, this "ash" is dissolved in hot water, and the solution crystallized in iron pans. (28)

PASTE.

To make paste that will keep a long time, Geo. G. Noah mixes with each hundred pounds of flour five pounds of alum, eight ounces of sulphite of lime, and two ounces of oil of sassafras.

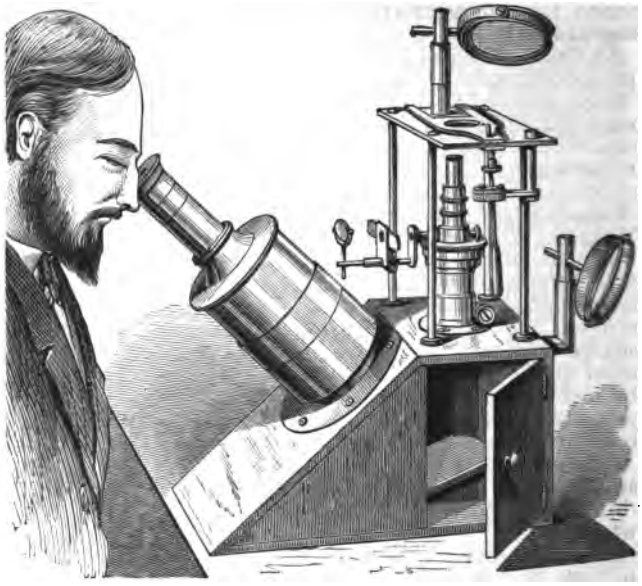
METALLIC PRINTING.

MANY attempts have been made to produce patterns upon cotton, worsted, and other tissues, by depositing reduced metals upon them. One of the most successful experimentalists in this direction was the late Mr. W. Robinson, of Clifton Vale Print-Works, Brighouse, Yorkshire. He found that lead, tin, bismuth, copper, etc., could be deposited in given designs in a metallic state upon woven tissues, producing a variety of novel and striking effects. One serious drawback remains, however, to be overcome before this new style of printing can be adopted on the large scale. The metals capable of easy reduction and deposition have all, with the exception of gold, which is too costly for general use, a strong affinity for sulphur. When exposed in thin films to the action of the air, they are consequently easily tarnished, and lose their beautiful metallic lustre. Vial moistens tissues of cotton, silk, etc., with a solution of nitrate of silver, dries slightly, and then lays upon the cloth a metal plate with an engraved design in raised lines. Wherever this metal touches the cloth, the silver is reduced in fine black metallic powder, which adheres very tenaciously to the fibre and reproduces the design with great sharpness and delicacy. The process is most successful on fine, compact goods. A slight previous dressing or sizing is of use. The designs thus produced are permanent in air and light, and are not affected by washing in water, soap-leys, or dilute acid and alkaline liquids. They are, however, of no value, as they are devoid of that metallic lustre which alone is wanted. Black designs, perfectly permanent, can be produced to satiety with much cheaper materials than the nitrate of silver.

COLORING OF TIN-FOIL.

VARNISHED tin-foil is much used, especially by confectioners and others, for wrapping up their wares.

Springmühl confined himself entirely to aniline colors soluble in water, and obtained remarkably good results with both gelatin and isinglass. Of gum-arabic and gelatin, the latter was found cheapest and most durable and best. Collodion gives an exceedingly uniform and tolerably elastic coating, which, if too thick, does not adhere well, and can be removed as a thin skin. A solution of collodion as dilute as possible must therefore be used. The tin-foil is warmed a little, the *colored collodion* solution is poured over it, and the ether is allowed to evaporate spontaneously. If a thin layer of gelatin be first spread over, and then the collodion be poured on, the coating of the latter will adhere all the more firmly.



A NEW MICROSCOPE WITH LARGE FIELD.

By P. A. Van der Weyde, M.D.—All microscopists know by experience the difficulty under which they often labor, when certain definite objects are searched for, of which only very few may be found in comparatively large quantities of liquid, say a whole drop, expanded under the covering glass. This difficulty is caused by the small field which the ordinary eye-pieces afford, and which does not allow to see more than a very small fraction of the surface under examination. It is very much like searching for a pin on a carpet of 20 feet square, while looking through a tube or hole of one or two inches diameter, and moving this over the floor. The chances of finding the object searched for are then, of course, very small indeed, and consequently the probability of missing the same very great.

This is often of much importance, for instance, in making a diagnosis in regard to renal diseases; a single object found in the urine may decide the matter; in searching for certain species of diatoms among hundreds of others, a large field is, to say the least, very convenient, and this is the cause of my giving some attention to find the best

means for enlarging the field, while retaining sufficient magnifying power to see the objects searched for.

As the field depends on the eye-view, this was enlarged, and a combination of curves calculated which would allow a large middle line of 2½ inch diameter, and corresponding large diaphragam, all inserted in a tube of the form of a truncated inverted cone, attached with its smallest end to an ordinary microscope. Such forms of tubes are an old device, and often found in old microscopes from celebrated makers half a century ago, but not to be rejected for all that. When exhibiting this arrangement before the American Microscopic Society, of New-York, while attached vertically by means of a prism of total reflection, to the horizontal microscope of Chevalier, it gave occasion to much merriment, as the tube looked much like a locomotive chimney. When we remarked, however, that the proof of the pudding was the eating thereof, and wanted the members to look through this microscope, the united testimonial was so encouraging, that we concluded to continue on the same track and to have an eye-piece made of 5 inches diameter, that is to say, an eye-piece of which the middle line is of that size with proportionate diaphragm, while the lens nearest to the eye need only be of one or two inches.

After this eye-piece was executed, it was found to be so large and heavy that no ordinary microscope stand could support it; it was so high and top-heavy as to be unmanageable, while it looked simply ridiculous. Very naturally the idea suggested itself to use this eye-piece for an inverted microscope, in the form of those of Natchez, in which the tube is placed low, under an angle of about 45°, receiving the light by reflection from above, while the objective stage and object is placed above the reflector; the light is thrown downward from the customary mirror placed above the object.

In order to give proper stability to this microscope, and at the same time make it at the minimum expense, the base was simply made of a mahogany box, with one side oblique, under an angle of 45°; on the oblique side (see the figure,) the eye piece is attached; it receives its light from a reflector inside the box, inclined under an angle of ½ × 45 or 22° 30′ with the horizontal plane. This latter reflector receives the vertical rays of light from above, coming down through the objective, and object on stage from the mirror placed on the top of the instrument.

For the purpose of focussing, the large eye-piece is contained in a sliding tube, and also the objective, while the slow motion is obtained by a screw which lifts the stage

and object; the necessary sideward motion of the objects is obtained by a rod, of which one end is attached to the moveable stage and the other end provided with a small handle, while it is half way of its length inserted in a ball and socket joint. By this arrangement the direction of the motion of the hand is inverted, but as the compound microscope also inverts the object and its motion, the object appears to move in the direction of the hand, and not in an opposite direction, which is very inconvenient for those not very familiar with the use of the microscope.

This arrangement, a modification of which is used in some ordinary microscopes, has never been applied to the inverted microscope.

The mirror at the top is so arranged, that it may be used for oblique illumination, and also may be placed at one side below the stage, so as to throw the light obliquely upward to illuminate opaque objects from below, as shown in the figure.

A peculiar additional contrivance may be mentioned, serving to measure the line of object. At the side of an adapting piece, connecting the object glass with the tube, a small lens is attached, by preference of the same focus as the lens used for viewing the object; in the focus of this lens, a micrometer scale or glass is placed, illuminated by a small mirror behind the same; inside the tube a small piece of covering glass is introduced under an angle of 45°, which throws the image of this micrometer through the tube into the eye, at the same time that the object is seen directly; while, by changing the inclination of the mirror, it is easy to bring the image of any division of the micrometer on the object seen. If a perfect piece of glass is used, it does not interfere with the sharpness of the image; if not perfect, it may be easily removed when sharp vision is required, and only introduced when microscopic measurements are to be made. I found in practice that a mere splinter of covering glass is sufficient to obtain a sufficient view of the micrometer.

When both lenses have not the same focus, allowance is made for this difference, the magnifying power of each being determined before taking the measures with the micrometer.

TREATING RAW-HIDE.—Articles made of the above material are liable to stiffen, warp, and shrink, and to overcome this difficulty H. W. Southworth suggests that the hides be first saturated in water, and then immersed in glycerine from eight hours to five days, according to the degree of flexibility desired.

ADAPTATIONS OF CELLULOSE.

If linen rags or wood saw-dust be fully dissolved in ammoniacal copper solution, and the solution then allowed to evaporate to dryness, a semi-transparent, brittle glass is left, for which no use has yet been discovered. But if the action of the solvent be prevented from effecting more than a commencing superficial solution, in which the fibres maintain their original form and disposition, remarkable results are obtained. A sheet of paper, left only an instant in the ammoniacal copper solution, and then passed between rollers and dried, becomes quite impervious to water, and does not lose its power of cohesion at the boiling heat. Two sheets of paper thus treated adhere firmly together, and form one piece. By treating a large number of sheets of paper in the same manner, artificial boards are obtained. Linen pieces thus treated furnish a very elastic material of great cohesive strength. Linen and paper may also be treated together, and a material is obtained said to surpass every kind of wood in point of firmness and strength.

Extremely serviceable roofing tiles may be thus made, resisting all irregularities of wind and weather. Pipes for conveying water and gas, articles of clothing, and even boats, can be constructed with this material.

ACID AND WATER-PROOF BAGS.

A material claimed to be acid and water-proof, suitable for making bags, roofing, etc., introduced by H. W. Johns, is made by coating canvas with a compound of paraffine wax, paraffine oil, carbolic acid, and asphaltum, and uniting therewith strong manilla paper saturated with paraffine reduced with naphtha. In addition to the manilla paper on one side, a coating of ordinary roofing paper may be added to the other, if a very heavy material is required.

Sugar-Melters.—Sugar-melting machines usually have a revolving stirrer formed of perforated pipes, through which steam escapes to operate on the sugar. These stirrers are mostly turned by gearing connected with the shafting, and to save the necessity of this connection, William Hocking proposes to arrange the stirrer in the same manner as the well-known Barker mill, so that it may be revolved by the reaction of the escaping steam.

Purifying Paraffine.—To hasten the filtration in purifying paraffine wax from the oil, Francis X. Byerly creates a vacuum by a pump attached to the receiver at a point below the perforated false bottom on which the paraffine rests.

MONOCHROMATIC SUNLIGHT.

MR. J. EDWARDS SMITH, of Ashtabula, Ohio, obtains monochromatic light by means of a combination of light-blue and dark-green glasses. He gives the preference to a single blue glass with two or three green ones, as may be ascertained by trial of various shades. He suggests the mounting of several such sets, of varying depths of shade, so that either set can at will be brought over the hole in the shutter. With such a combination, without other special apparatus, he easily resolves all the shells of Moller's Probe-Platte; and he considers the light thus modified as good as the more nearly monochromatic light of the ammonio-sulphate cell.

ANTIDOTE FOR PHOSPHORUS.

BASED upon experiments very successfully made with animals, Drs. Eulenberg and Wohl propose the use of animal charcoal, made up into pills, as an efficient antidote against the bad effects of phosphorus in the lucifer match manufactories; they prefer this substance to oil of turpentine, which, though an effectual antidote against phosphorus, causes, in many instances, severe headaches when internally taken.

A CEMENT for leather, wood, etc., resisting the action of water, both hot and cold, and most of the acids and alkalies. Three parts, by weight, of shellac and one part of caoutchouc are to be dissolved, in separate vessels, in ether free from alcohol, applying a gentle heat. When thoroughly dissolved, the two solutions are to be mixed. If the glue be thinned by the admixture of ether, and applied as a varnish to leather, it renders a joint or seam water-tight.

VARNISH FOR PENCILING.—Bleached shellac and sandarac, equal parts, dissolved in alcohol, four ounces to each ounce of the mixed gum, then add a little Venice turpentine. This varnish can be ground by simple friction with the bare finger, and bites the pencil to such an extent that transparent spots can be filled up without recourse to the brush. It is also quite soft and easily cleaned off.

NOVEL EVAPORATOR.—A method of extracting substances from solutions, syrups, etc., devised by Samuel R. Percy, consists in atomizing the solution by means of currents of dry air acting through the medium of any suitable atomizer, whereby the liquid is dissipated in the atmosphere and the solid substances therein contained fall to the floor.

NEW PRODUCT FROM PETROLEUM.

IT is stated by Robert A. Cheesebrough, that if the residuum left in the still after the greater part of the petroleum is driven off be filtered through bone-black, a thick, oily, pasty substance is produced which he calls "vaseline." It is unobjectionable in odor, becomes fluid at a temperature of from 85° to 110° F., and is then transparent. It varies in color from a pure white to a deep claret, according to the quality of the residuum, the quality, fineness, and preparation of the bone-black, and the skill of the manipulator. It is said to be useful in currying and stuffing leather, as a lubricator, and the finest qualities may be used as a pomade for the hair.

REFINING PETROLEUM.

H. M. BAKER states that petroleum may be refined by distilling it in a retort provided with an agitator, by which it may be thoroughly worked and mixed with alumina or anhydrous clay at the rate of a quarter of a pound of the alumina to a gallon of oil. The alumina may be recovered from the residuum by burning the organic matter.

ARTIFICIAL STONE.—A process for making the above, devised by G. L. Eagan, consists in moistening a mixture of cement and sand with a solution of one pound of sal soda, one pound of bituminous matter, and one ounce of litharge in three gallons of water. This compound is moulded in blocks of the desired shape and allowed to set, after which silicate of soda or potash is forced into the pores, and the stones are then dried for use. Any desired color may be given by mixing the proper pigment with the silicate.

BURNING BAGASSE.—It is stated by E. S. Roman that by sprinkling bagasse with petroleum or other hydro-carbon, as it leaves the mill, it may be immediately run into the furnace and burnt as fuel.

PRINTING INK.—A method of making printer's ink, described by J. C. White, consists in mixing alcohol with tar, then firing the former and condensing the vapors arising from the combustion of the mixture. Ten gallons of the oil thus made is then mixed by boiling with one gallon of burnt corn-meal or flour, and about ten ounces of linseed oil as a drier.

TO utilize blast-furnace cinders, Fritz Lurman suggests that they be granulated and then mixed with quicklime or other caustic cement to form a compound for artificial stone, which may be moulded by pressure and dried in the air without burning.

FILLING FOR WOOD.

As a material for filling wood, Seabury proposes to use *terra alba*, which he states is superior to the ordinary materials used, as it does not require to be colored to match the wood on which it is to be used, which is a great advantage where it is to be employed on work composed of various colored woods.

CARBON BLACK.

To utilize the carburetted-hydrogen gas, which escapes in considerable quantities from oil wells, John Howarth collects the gas and passes it through burners, by which it is consumed under tiles or slabs of soapstone, on which the carbon black, resulting from incomplete combustion of the hydro-carbon, collects and is scraped therefrom at proper intervals.

SULPHURIC ACID.

AN apparatus and process for the manufacture of sulphuric acid devised by David Jackson may be described as follows: A reservoir in the upper part of a furnace supplies melted sulphur to a series of pans below. Over the pans pass pipes which supply air to the burning sulphur. The fumes pass into a condenser which is divided by a set of wire or hair sieves into compartments, where the solid particles of sulphur are deposited in several grades, the gas passing to the "denitrificator" over sulphuric acid contained therein, and thence to the reaction chamber, and is discharged up through strata of weak nutric acid, the fumes ascending through perforated shelves containing piles of cinder, pumice-stone, &c.

EXPLOSION OF WET GUN-COTTON.—Experiments made by Mr. Brown, chemist in the British War Department, show that gun-cotton can be exploded when comparatively wet, or when containing from 15 to 20 per cent of water. It has heretofore been supposed that this material when damp was inexplosive, and could thus be rendered safe until dried for use.

COKING COAL-SLACK.—The slack of some species of coal has so little bitumen in its composition that it can not be coked by any of the present processes in use; but George Lander states that by heating the ovens to a high degree, and then charging with the slack, the bitumen will come to the surface of the particles, and unite the slack together in a mass or masses. At this point the mass is agitated and treated in the same manner as other coal in making coke. Another method suggested is to mix with the slack from ten to twenty per cent of coal or slack which is rich in bitumen, and treat as before.

CORALLINE FOR WOOL PRINTS.

THIS coloring matter, much used in dyeing wool, has been but little employed in printing on wool. The reason of this is, that in printing wool with coralline, the color is almost sure to come in contact with acids in the various processes employed, when the red color fades into yellow. In order to prevent this injurious effect, the author employs calcined magnesia with advantage, and with coralline soluble either in water or in alcohol. The resulting color is a rich Turkey-red, which maintains its intensity and brilliancy for years. This red is about 30 per cent cheaper than cochineal red, and has the advantage over the latter in that, by washing in water containing calcium carbonate, it does not pass into a blue shade, the only disadvantage being that of its fading in contact with strongly acid colors, if the acid be more than sufficient to neutralize the magnesia. The following mixture is recommended for printing:—

80 grams coralline.
1-16 litre glycerin.
1-4 " water.
140 grains magnesia, well stirred up with 1-4 litre of water.

The whole is thickened with $\frac{3}{4}$ litre of gum-water (500 grams to the litre), and printed, steamed, and washed in the usual way.

Coralline may also be printed on cotton, the color being thickened with starch and egg-albumin in addition to magnesia. This mixture must be used fresh, as in time an insoluble compound is formed between the magnesia and albumin. (5)

PURIFYING AND COLORING PARAFFIN.

A PROCESS has recently been invented in England by Mr. John Fordred, in which the use of naphtha and other volatile solvents is rendered unnecessary, and the manufacture rendered less dangerous. This is accomplished by a kind of kneading action on the crude paraffin, while it is immersed in a bath of warm soap and water, the paraffin being placed in a suitable bag and affixed to a revolving wheel. After it is taken out of the bag it is subjected to the action of sulphuric acid and fuller's-earth, at a temperature of 300° Fah., which absorbs all the coloring matter and renders the paraffin as white as snow.

Mr. Field, F.R.S., in a recent lecture on the paraffin industry, mentioned the fact that after a long series of experiments, aniline colors have been successfully introduced into paraffin. Magenta, for instance, is perfectly insoluble in the substance, but by the application of magenta and stearic acid into the purified paraffin, a most beautiful color is obtained.

ENAMELING WITH RUBBER.

ACCORDING to a process discovered by Perry Finley, articles may be enameled with rubber or gutta percha in the following manner:—The gum is first submitted to a high degree of heat, ranging from 240° to 320° F. in a still or a steam or sand bath, by which it is converted to a plastic or fused state. This operation may be facilitated by the addition of fifty per cent. of caoutchoucine, naphtha, or linseed oil. When thus reduced it will be found to have aquired new properties, and articles coated with it, if subjected to a high degree of artificial heat, will be found covered with a vulcanized enamel of rubber but without having the admixture of sulphur heretofore necessary in vulcanization. For economy in manufacture, graphite, feldspar, ground slate, gas carbon, silex, charcoal sulphate or carbonate of lime, magnesia, gum animé, asphaltum, gum copal, or gum shellac may be added. To produce colored enamels, such colors must be used as will stand a high degree of heat—as vermilion, sulphide of cadmium, or the oxides of zinc, antimony, or iron.

MANUFACTURE OF INDIGO.

IN the manufacture of indigo it is necessary that the aqueous extract should be thoroughly agitated and aerated, and to accomplish this, T. T. Woodruff provides an oval tank having a division along the centre, which does not, however, extend entirely to the ends. On one side of this division is a paddle-wheel which, by its motion, keeps up a continual circulation of the extract; and in the bottom of this tank are two perforated pipes communicating with air-pumps, through which currents of air are continuously forced. To dry the extract, it is placed in a dryer on inclined mats, around and over which a current of hot air is constantly passing, and when dry, the indigo is made up into blocks for the market by compression in moulds.

GELATIN FROM ALGÆ.

W. J. RAND proposes to make gelatin by taking that species of *algæ* known as *chondus crispus*, and *plocaria candida*, or *agar-agar*, and soaking it in a bath containing about ten per cent of carbonate of ammonia, which decomposes the iodine, bromine, etc., then removing it to a bath having two per cent in excess of citric acid, and driving off the ammonia by heat at about 140° F. By this process it is partially desiccated, and then dissolved in water at a temperature of 160° F. It is then thoroughly desiccated in flat pans and afterward powdered, when it is ready for sale or use.

SPOOLING SILK.

To suit the requirements of the market, each spool should have a definite weight of silk run on it. To accomplish this, H. L. Brown places the bobbin from which the silk is to be wound on a scale, which is counterbalanced by ounce-weights, if the spools are to receive an ounce, or with corresponding weights if more or less than an ounce is desired. One of the ounce-weights is now taken from the counterbalance, and the silk is wound from the bobbin on to the spool on which it is to be sold, and as soon as an ounce of silk has been unwound from the bobbin the scale will turn, indicating that an ounce has been wound on the spool. Another weight is now removed from the counterbalance, and a second spool is wound, until the scale turns as before.

BRAID-GUIDE.—A convenient style of braid-guide for sewing-machines suggested by J. B. Price consists of a small disk set in the presser-foot, having several apertures of different sizes. Either of these apertures may be brought into position for use according to the size of braid to be sewed by turning the disk until the proper guide is nearest the needle.

SEPARATING FIBRES.—A new process for obtaining fibres from stalks, leaves, etc., suggested by William Adamson, consists in subjecting them to the vapors of hydro-carbons, which will remove all the gummy matter, and then washing them in a weak alkaline solution to separate the fibres from the non-fibrous matter.

SEPARATING WOOL FROM COTTON.—A process for this purpose, devised by J. H. Collins, consists in boiling rags of mixed fibres in a solution of sulphuric acid, salt, alum, and water from four to twelve minutes, then removing and rinsing in water, by which the cotton fibre in the rags destroyed by the action of the boiling mixture will separate and leave the wool.

DYEING WITH NAPHTYLAMINE COLORS.—It is stated by Francois Lamy, *fils*, that fabrics may be colored a puce-garnet, a violet, or reddish violet, at less cost than by the usual process, by first printing them with a salt of naphtylamine to which chlorate of potassa or hydrofluosilicic acid and thickening have been added. After exposure to the air the color is fixed by subjection to a bath containing the bichromate of potassa, and nitric, sulphuric, or hydrochloric acid. The garnet shade is developed by a bath containing an alkaline chloride or ammonia; the violet by a bath of nitrate of iron and *aqua regis;* the reddish violet by chloride of iron, a copper salt, and *aqua regalis.*

PRESERVING CHARRED PAPERS.

MR. E. H. HOSKINS, of Lowell, Mass., has suggested a very useful and practical way of preserving and giving toughness and flexibility to charred paper, which has proved to be of much importance in the identification and copying of valuable documents, charred by conflagrations such as the recent Boston and Chicago calamities. We have seen specimens of charred papers and bank-notes thus treated, that can be handled with impunity. The printing upon the charred bank-notes can be readily discerned. The preserving process consists, we believe, in pouring collodion upon the surface of the charred paper. The collodion forms a thin transparent film, dries in a few minutes, and the process is complete.

MILDEW-PROOF CLOTH.—According to a statement of R. C. Sturges, cloth may be made mildew-proof by boiling for three hours in water having dissolved therein fifty pounds of common salt, four pounds of lime, and one pound of alum.

DYEING GOODS WITH MADDER.—Messrs. Alex. and Arch. Duncan state that by passing goods through a saturated solution of the coloring matter of madder or artificial alizarine, at a high and equable temperature, instead of a low and gradually increasing one as usual, the time necessary to dye the material may be shortened from the ordinary time of from one and a half to three hours, to from three to fifteen minutes.

CARDING-MACHINES.—It has been suggested by Ephraim C. French that considerable time and labor may be saved by causing the reciprocating "fancy roller" in carding engines to revolve in contact with both the main cylinder and "doffer." He states that under this arrangement the latter may remain two or three weeks without being cleaned, instead of requiring this operation at least once a day, as in the old plan.

TO PREVENT GLASS LAMPS FROM BREAKING, from an accidental fall, Adolph Otto proposes to place a thick rubber band on the exterior of the lamps. Channels are cast for the reception of the rubber.

PURIFYING GAS.—Gas as furnished by the gas-works is often so impure as to damage the furnishings of the houses where it is burnt, and endanger the health of the inmates. To obviate this, W. T. Kosinski proposes to provide dwelling-houses with small gas-purifiers containing alternate layers of lime, charcoal, and acetate of lead, through which the gas will pass on its way to the burners.

IMPROVEMENT IN PHOTO BACKGROUNDS.

A NEW method of preparing and printing photographic backgrounds, introduced by Daniel and David Bendann, consists in preparing a painted background with the high lights lighter and the dark shades darker, so as to secure graduated lights and shades that will produce the desired effect. Any object to be furnished with this background has a negative taken and the photograph printed in the ordinary way, until ready for toning, when the negative of the object is removed and the background negative adjusted over the print just made, and is printed thereon, the object first printed being protected by a mask roughly shaped in its form, placed above the background negative directly over the object, and the artist by manipulating this mask harmoniously blends the background with the outlines of the object already printed. When the background has been printed, the completed picture is toned in the ordinary manner. Any number of negatives of original backgrounds may be taken and furnished to photographers, so that negative portraits may be taken and in printing each photograph may be furnished with a different background of the most artistic description.

NEWSPAPER PHOTOGRAPHY.

AN apparatus for printing newspapers and other similar matter, proposed by C. A. Waterbury, consists of a double camera or two cameras placed back to back, between which a continuous sheet of sensitized paper is fed intermittently by appropriate mechanism. In front of the lenses negatives of the paper to be printed should be suspended, one of which should correspond with the inside pages, and the other with the outside of the newspaper. Between the lenses and the negatives are gates which automatically shut off the light during the motion of the paper, but when the paper is stationary they open and allow the printing to take place, and by this means, it is claimed, newspapers or other matter may be rapidly printed on both sides.

GELATINE PRINTING-FORM.

A GELATINE printing-form complete in itself, without a base, which has the printing image produced upon it by light, and which can be used in the printing press for a number of impressions, then put away and at subsequent periods used again, is produced by Ernest Edwards by pouring over a level glass plate a solution of one ounce of gelatine, five grains of chrome alum, and a half dram of bichromate of potash, and after the solution has set drying it at a temperature of about 75° F. When dried, the

film is stripped from the glass plate and then printed by exposure under a negative. It is then placed under water upon a polished pewter plate, coated with a solution of india rubber, and quickly withdrawn, after which the two surfaces are pressed into close contact and the plate is steeped in water until the bichromate is soaked out, and it is then ready for printing from. To allow the film to be readily removed from the plate on which it is formed, the latter should be rubbed with a solution of wax, collodion, or india rubber. Forms thus made can be rolled up or handled in any manner, without injury to the plate.

PHOTOGRAPHIC ENGRAVING.

A METHOD of preparing plates for printing by the photographic process described by W. B. Woodbury, consists in preparing a film of bichromatized gelatine mixed with a granular material, which is exposed under a negative, and then attached to a metal plate, after which it is washed in water to dissolve out the soluble parts not affected by the light. The result of this is the production of a relief with a granular surface, the grains being more aggregated at the prominent portion of the relief. When dry, it is placed on a smooth plate of a soft alloy of lead and antimony, and run between rolls, resulting in a granular impression on the soft metal. An electrotype is taken from this, and from this last plate a second is taken, which may be used in printing, as in the copperplate process. Plate prints produced by this method have a fine mezzotint-like appearance.

USE OF CASEINE IN PHOTO-ENGRAVING, ETC.

THE use of "caseine" in preparing plates or blocks for printing by surfaces in relief, photo-lithography, zincolithography, etc., is suggested by Thomas J. Denne, who uses it by coating a block or plate of card-board, wood, metals, or other suitable material, with a compound of caseine and china-clay, pipe-clay, flake-white, or similar substances, mixed with a little glycerin or salt, then smoothing the coating and afterward making it insoluble by brushing over with a weak solution of acetic acid. If a block or plate so prepared be sensitized and printed on in the usual manner, a surface in intaglio or relief, as desired, may be obtained by "washing out" in the ordinary way For photo-lithography, he uses a composition containing caseine, soap, and bichromate of potassa as the coating. In zincophotography, the zinc plate is covered with a thin layer of the last-named compound printed under a negative, the unprinted portion washed away with ammonia water, the print made insoluble with acetic acid, and then etched as usual.

GLAZING PHOTOGRAPHS, PRINTS, ETC.

MESSRS. DENNE & HENTSCHEL propose the glazing of photographs, prints, or other papers, by covering them with a surface of "caseine" dissolved in a solution of soap and water, or in water to which a few drops of ammonia have been added. The coated print or paper is then subjected to a bath of water and acetic acid, and then laid on a glass plate, (which has been previously rubbed over with gall,) and then pressed smooth to squeeze out the air and the superfluous moisture. When dry, the paper and film of caseine will leave the glass, and the paper will be found coated with a smooth, glass-like surface that is insoluble in water.

STEREOTYPE MOULDS.—The use of asbestos in the paste used for making *papier-maché* stereotype moulds has been suggested by Samuel Crump, who states that they will thus be better able to stand the heat of the fused metal.

PHOTO ENLARGEMENTS.—By a new process for photographic enlargements the finest pictures, from small negatives, enlarged to any size desired, are produced in London. So perfect is the process that many of the best photographers have expressed the opinion that the employment of the large and expensive lenses for gallery work will no longer be necessary.

MAKING UMBRELLA RIBS.—Instead of flattening and drilling or punching the ends of the ribs, as is now the custom, J. McAuliffe surrounds the ends of each rib with a short tin tube, which is fastened by placing the rib in a mould and pouring in solder, which securely holds the two together, and forms a neat finish. A multiple mould is used, in which several ribs are inserted so that the ends may be finished very rapidly. The tips are formed in the same manner. By this method of manufacturing it is claimed that the ribs can be hardened and tempered by running the wire through a gas flame instead of the present process of hardening and tempering after the ribs are formed, and therefore a much more regular temper may be obtained at less cost.

LIQUID SOAP.—James Leetch proposes to make a liquid soap by adding to one third of a gallon of soluble glass one gallon of water, in which six ounces of sugar has been dissolved, and two ounces of chalk. This compound may, it is said, be used on the stoutest canvas or the most delicate lace, and does not affect colors, but will take out stains. It may be used with sea water, either hot or cold.

MOULDING EARTHENWARE.

PLASTER moulds are ordinarily used in moulding earthenware, and they have to be set aside for some time after each article is moulded, necessitating a number of moulds; and Messrs. Leak, Moore & Taylor therefore propose the introduction of metallic moulds heated to 212°, which may be used several times in succession with one heating.

MANUFACTURE OF BOOTS AND SHOES.

A MACHINE for the above purpose, designed by G. V. Sheffield, which inserts rivets from the inside of a boot through the sole, has the rivets blown through the "horn" on which the shoe rests by a blast of air. On account of the peculiar shape of the horn necessary to reach the inside of the toe of a boot or shoe, the rivet has to follow a rather tortuous course before it can be set in its place, which makes its insertion difficult by any ordinary mechanical movement; but, by dropping the rivets one at a time from a hopper into a small pneumatic tube extending through the horn, they may, it is said, be inserted in their places with great rapidity and ease by the force of a blast of air from a cylinder in the rear of the tube acting on the rivets' heads.

NOVEL BRUSH.—A new style of brush, suggested by Robert Ashworth, consists of a stiff back to which is secured some elastic material—as rubber, for instance—having short, fine wires projecting through it in place of the bristles usually employed. To compensate for the want of elasticity in the wire, the soft material will yield a little, and so conform somewhat to the object being operated on. As the pins or wires are not affected by hot water, the brush is supposed to be much more durable than one made of bristles.

PEAT FUEL.—As an improvement in the method of preparing peat for fuel, William S. Tisdale proposes to add to it a small proportion of unslacked lime, which will enter into chemical combination with the water contained in the wet peat as it is taken from the bed, and render it by absorption comparatively dry.

OPERA-GLASSES.—A new style of opera-glass introduced by A. V. Ryder has, instead of the tubing usually employed, flexible material, as cloth, leather, etc., which folds together like Chinese lanterns. To hold the lenses at the desired focus, the two pairs are connected by a "lazy tongs," having an adjusting device for governing the amount of the extension. By this arrangement an opera or field glass can be compressed into a very small space.

IMPROVED BOTTLE-LOCK.

AMONG the minor novelties is the bottle-lock, shown in our cut, which consists of a wooden plug made in the form of a cork, and composed of two parts, between which are a series of rubber disks. The centre of the plug is traversed by a screw, the head of which is square, and is turned by a corresponding key. By turning the screw, the two parts of the plug are brought together, which compresses the rubber and causes it to expand and tightly press against the interior walls of the bottle neck. So strong is this pressure, that it is impossible to remove the stopper from the bottle, until the screw is relaxed; and as the owner carries the key, the contents of his wine bottle are preserved from depredation, while access of air is likewise prevented.

BUILDING PAPER.—A method of making plain paper water-proof, so as to fit it for use as an inner layer in building, consists, as suggested by C. B. Ayer, in passing the paper through a solution of alum or through a solution of the salts of iron or zinc, and next through a sizing mixture.

GRINDING WHEAT.—It is stated by Lewis S. Chichester, if wheat is heated to 150° F., and ground at about 100°, that a superior quality of flour will be produced, as the article is toughened, and therefore is not cut up so fine as to discolor the flour; and as the flour is less liable to adhere to the hulls it is less likely to pass off with them.

INSECT-DESTROYER.—According to G. Barker, a mixture of ten parts of lime and one of nitrate of potassa scattered over plants or trees will destroy or drive away the potato-bug, currant-worm, etc., without injury to the fruit, even if eaten shortly after.

COLOR FOR PAINT.—According to Herman Petsch a coloring material for painting, &c., may be obtained by dissolving five parts of sulphate of copper with one of sulphate of zinc in water, adding to this solution another one of caustic soda or potash to precipitate the coloring matter (oxides of zinc and copper), then pouring off the liquid, and washing and drying the precipitate. A dark green color will thus be obtained, which may be afterwards ground with oil.

NEUTRAL SOAP.

By M. Mialhe.—I take the ordinary toilet-soap of commerce, which has been made by the cold process, reduce it to shavings, which placed on tiles are exposed in a convenient chamber to the action of carbonic acid gas. The soap absorbs a volume of carbonic acid gas proportionate to the quantity of caustic alkali which has escaped saponification, converts it into bicarbonate of soda, and as a consequence, all causticity is destroyed. A neutral soap remains, containing all the glycerine of the fatty matters employed in its preparation, with a certain quantity of bicarbonate of soda.

Pianofortes.—To increase the volume of sound in these instruments Thomas Winans proposes to attach a second set of strings above the others, both sets to be tuned in unison. Two sets of dampers should be used, one for the main strings and the other for the auxiliaries, so connected as to move together to act on their respective strings, but only one set of hammers, the upper strings not being struck, but acting sympathetically with the vibration of the others.

New Building Material.—To utilize the large deposits of asphaltum found in California, John L. Boone proposes to mix it with fibre and press it into moulds, and so form fence-posts, telegraph-poles, piles, railroad-ties, building-blocks, etc. When intended to be used for building the blocks may be sprinkled over with marble dust, lime, or other finely pulverized dust, while the blocks are yet warm, and again compressed, and thus form a smooth coat over the surface.

Rulers.—To prevent round rulers from slipping on the paper or desk when used to make parallel lines J. M. Batchelder proposes to encircle their ends with small rubber bands which will not only prevent slipping but will raise the ruler so far from the paper as to prevent blotting by ink left on the ruler.

Moulding Paper Pulp.—A new apparatus for moulding hollow articles of paper pulp,—such, for example, as hats,—devised by Kendall & Trested, consists in the use of a tank containing the pulp, at the bottom of which is a mould of the object to be formed, made of wire gauze. Beneath this a steam-jet is introduced, which takes with it the air from the interior of the mould, thus creating a vacuum and causing the liquid in the pulp to pass through the gauze, leaving the solid part thereof on the upper side of the mould.

SHOVELS.

A SPECIAL form of sifting-shovel, used to some extent around gas-works, is made of soft malleable cast-iron, and as a consequence of the use of this material the edges are soon worn out. Mary J. Butler therefore suggests that their durability may be increased by setting in the mould used for casting a piece of sheet-steel, which shall form the lower edge of the shovel, it being so held in the mould that the cast metal shall partly surround it and hold it firmly.

THIMBLE TOOTH-BRUSH.—A new form of tooth-brush proposed by G. M. Allerton is made of india rubber with the back in the form of a thimble so that it may be secured to the end of the finger and used without a handle, and be thereby more easily applied to the different portions of the mouth.

NOVEL CLOCK CASE.—A clock introduced by C. W. Roberts has its case made in the shape of a right-angled triangle so as to fit it to be set in the corner of a room. The advantages claimed are that it can be seen better from all parts of a room, and that the clock can be adjusted in the factory, so as to run without further adjustment in the house.

RUBBER PAINT.—BY S. F. MATHEWS.—An extremely durable paint may be made, according to the author, be first macerating rubber in any of the solvents until of a pasty consistency, next dissolving it in linseed oil heated until the solvent is evaporated, and then mixing in by grinding a proportionate quantity of graphite.

COMPRESSED SHOE-PEGS.—Oliver G. Healy suggests that if the peg be compressed immediately previous to driving, that it will afterward swell and hold the leather much more firmly. In pegging-machines this should be accomplished by compressing the peg-wood strip and cutting off the peg after the strip has been compressed.

NOVELTY IN CANDLES.—A new method of making candles, suggested by John R. Trux, consists in the use of a wick frame having a series of holes on two sides, through which the wicking is passed backward and forward until all the holes are filled. This frame is set in a mould, into which tallow, wax, or other material is run, so as to form a solid block of the material, through which runs the wicking in straight lines. The wick frame is then removed, and the block cut up by gang-saws into square candles, which are afterward trimmed round by appropriate machines.

PAPIER-MACHE FOR INTERIOR DECORATION.

THE newest and most improved method of manufacture of papier-mache is that introduced by a well-known decorative artist in this city. The first step in this process is to carve the required object out of plaster, the utmost care being taken to make the lines of the work perfectly sharp and delicate. From this model, a plaster mould is made in several pieces, so as to render it easily taken apart or put together. Into this mould a thin layer of the finest paper pulp is poured, care being taken that every portion of the mould is thoroughly covered. To back this thin covering a thick pulp, made from cane fibre, generally bamboo, is employed. This substance is used because it is perfectly homogeneous and sets firm and hard in the mould. So strong are the casts thus made that they can be constructed as thin as canvas in pieces of twelve feet square. Whole ceilings, cornices, and sides of rooms can thus be made of any degree of elaborate ornamentation, and apartments completely finished without the use of plaster; the paper being attached to the walls by ordinary nails and screws. Besides being used for ceilings and cornice-work, this material has been found to answer every purpose as an imitation of heavy carvings on furniture. A curious bed of decayed vegetable matter, somewhat resembling peat, has lately been discovered in a forest near Paterson, N. J., portions of which, when mixed with the cane fibre pulp, give the composition, on its becoming hard, the exact color and appearance of black-walnut, resembling the wood so closely as to require careful inspection to distinguish it therefrom.

For delicate tracery in cornices, papier-mache is far superior to plaster, on account of its strength and superior lightness. Mixed with clay, glues, and an alkali, it is perfectly fireproof, and the addition of silicates renders it impervious to the action of moisture. It is in use, as we stated in the beginning, in many of our finest theatres; and even in churches it is largely employed to imitate the stone capitals of pillars or the heavy groined arches which apparently support the roof.

PAPER BOARDS.

To make a thick yet cheap board, and one that will not warp, such as is needed for show-cards, etc., B. T. Harris proposes to use two thicknesses of paper or card-board having between them a layer of plaster of Paris. To prevent the too rapid hardening of the plaster, and to toughen it, a portion of ground althea root is mixed with it.

INCREASING THE THICKNESS OF ICE.

ICE in rivers, lakes, etc., may be rapidly increased in thickness by an apparatus designed by Louis Townsend, consisting of a series of sections formed of two planks, having their edges secured together at right angles, and strengthened by braces at their ends. As soon as ice is formed sufficiently thick to bear the weight of the workmen, a number of these sections are connected together so as to inclose a space proportioned to the quantity of ice to be gathered, and the edges of these sections are sprinkled with water and frozen water-tight. A hole in the ice outside of the inclosed space is now broken, and water pumped from it into the space, which water rapidly freezes, and ice of great thickness can thus, it is alleged, be formed in a very short time, which may be cut up in blocks suitable for storage.

NEW ICE PITCHERS.—To prevent the injurious effects sometimes resulting from the solder used in metallic water pitchers, L. N. Wilbur and A. Tyler, of Fitchburg, Mass., have designed a rubber lining for such utensils. They introduce a thin sheet of rubber within the pitcher, and by means of a former they press the rubber evenly against the interior walls, and then apply heat. The rubber is thus caused to adhere to the vessel, forming a complete and thorough lining.

E. A. Parker, of West-Meriden, Ct., suggests a durable walled ice-pitcher having its outer wall made of paper.

PAINT COMPOUND.—A cheap paint, claimed to be fireproof, suitable for out-door work, tools, etc., may be made, according to W. H. Foran, by mixing four gallons of coal-tar, one gallon of linseed oil, one gallon of dead oil, one half gallon of a solution of gum tragacanth, and two pounds of soda ash dissolved in lime-water. It may be thickened with sand or ground slate, and colored by Lehigh or French yellow, or whitened by the use of "whitewash putty" or chalk.

LUBRICATING OIL.—A cheap lubricating material, introduced by G. W. Gladden, is made by boiling for six hours sixteen hundred gallons of the residuum of petroleum oil with one hundred and fifty gallons of Carolina tar, and then adding sufficient petroleum oil to reduce it to the proper consistency.

NEW DENTAL INSTRUMENT.—To prevent the tearing out of a piece of the alveolar process with the root in extracting teeth, John D. Chevalier has introduced forceps having cutting edges at or near the centre of the beaks for cutting through the process.

BALLASTING SHIPS.

SHIPS in port, when unloaded, have to be ballasted to prevent the danger of careening. The expense of taking this ballast aboard and removing it when the vessel is again loaded, is considerable; and to save this, Messrs. Demartini and Chertizza propose to attach to the sides of the vessels, by chains or other suitable means, a series of heavy logs for ballast. These logs are to be loaded so that they will just float, and will not act on the vessel to any appreciable extent until she begins to careen, to do which will cause her to lift the logs out of the water, and their weight will cause her to "right" immediately.

PRINTER'S CASE STANDS.—A convenient style of stand for the use of job printers, devised by Robert Chapman, has a series of frames each consisting of two side pieces and a top on which the case rests. These frames are of various sizes so as to "nest" together, and they all rest on a rod running from one side of the main stand to the other, in such a manner that either of them can swing toward the compositor and present the entire case to his view, so that a few lines may be set from it without removing it from the frame, or running the risk of its falling if used in the frame by partially drawing it out.

PRINTING-PRESS AND FOLDING-MACHINE.—To save the expense of feeding papers to folding machines, Edward L. Ford suggests that a folding-machine be combined with a printing-press by means of a series of endless belts or tapes, which shall take the sheet from the "flyer" of the press and convey it to the folding-machine. The tapes or belts should be so arranged as to be thrown out of gear in case of any derangement of the folding apparatus, so as not to interfere with the operation of the press.

SHEARS.—A new style of shears, designed by Joseph Gardner, have a toothed segment formed upon one blade at the pivot which fits into and works in a rack contained in a recess in the opposite blade. The pivot is fast to the blade having the segment, and works through a slot in the other blade. By this arrangement the segment works on the rack, as the handles are operated, giving one blade an endwise motion, thus producing a "drawing cut."

ARTIFICIAL STONE.—J. J. Schillinger treats blocks of artificial stone by drying in a steam-chamber which makes the blocks much less brittle than when dried in dry heat. The blocks may then be dipped in silicate of soda and again dried. If very superior building blocks are required, they may be further improved by immersing them in a mixture of oil and beeswax.

TELEGRAPHING AT SEA.

CAPTAIN COLUMB, R, N., in a paper recently read before the Society of Telegraph Engineers, London, says: Telegraphing at sea by night was confined to a very few set messages, represented by white lights displayed in different numbers and forms; this was continued until 12 years ago, when what is now called the "flashing system" was introduced, which has since been completely adopted in the English navy and army. This is nothing more than the adoption of the "dot and dash" of Morse, or the "long and short flash," as they are now called, to universal application.

It was shown how, by the long and short display of a single light, the long and short wave of a flag, the long and short appearance of any object, or the long and short sound of a horn or steam whistle, all the present wants of telegraphing at sea were supplied.

The paper was illustrated by various diagrams aud specimens of apparatus actually in use, one of the most important being a flashing light, known as the Chatham light, of great power and simplicity, the light being produced by jets of diluted magnesium powder into the flame of a spirit.

It was shown that all telegraphy was reducible to a system of visible or audible signs followed in certain succession. The means of distinction in visible signs were difference of form, color, and motion; in audible signs, differences of tone and motion (or time), while semaphores represented form, and flags, color and form; the most powerful distinction of all, motion, was never practically employed until the flashing system made its appearance, but it not only threw open the hours of darkness to the purposes of telegraphy at sea, but it made the transmission of messages more rapid, while enormously extending their range. Instances were given of messages sent 30 miles from mid-channel to the coast of England at night, and of messages read by the naked eye in the daytime, when flags could not be read with the most powerful telescope.

NEW METHOD OF REPRODUCING DRAWINGS.

BY B. RENAULT.—The design being traced with adhesive ink on strong glazed paper, bronze powder is dusted over and adheres to the mark. The drawing is now applied to the surface of a sensitized paper, which is blackened by the reducing action of the metallic powder. By exposure to the vapor of alcohol, the ink of the original can be again rendered adhesive, and the operation can be thus repeated many times.

IRON-DUST FOR STONE-CUTTING.

As a substitute for the sand used with saws in cutting stone, B. C. Tilghman proposes to use cast-iron globules from one hundredth to one twentieth of an inch in diameter, which are to be fed into the saw with water, like the sand, or they may be fixed to the edge of the saw by solder or otherwise. These globules may be made by throwing off the melted iron by centrifugal force from a central reservoir, after which they may be case-hardened and separated according to size to suit the different styles of work in which they are to be employed. If used in the same manner as sand in sawing stone, they should be separated from the grit afterward by washing or by the use of magnets, so that they may be re-used.

SEA-WEED TUBING.

A NEW material for the manufacture of flexible tubes, such as are used for gas-extensions, etc., proposed by G. L. Burnham, is the stems and leaves of kelp—a common sea-weed, well known on our coasts. The stems are long and tubular, and when cured by saturating them for about four days in a mixture of equal parts of glycerin and carbolic acid, become soft and yielding, yet tough and compact in the fibre. The leaf should be soaked in fresh water, then split into two layers, and cured in the same manner as the stem. In use, the stems are drawn over a foundation of wire and woven fabric and then covered by braiding. The leaves should be lapped around the foundation and the outside braiding will close the edges and keep them gas-tight.

GANG BAND-SAWS.

BAND-saws are ordinarily used singly, but W. J. McLane has devised a plan of running a number together so as to form a gang to be used in cutting up logs into planks, boards, etc. This is accomplished by the use of two sets of cone pulleys provided with band saws of lengths corresponding with the diameters of the different pulleys forming the cones, so that each pair of pulleys of the cones will carry a saw.

SHOEMAKERS' TOOL.—It has been suggested, by J. F. Ober, that if the ordinary lasting pincers be provided with an awl at the side opposite to that usually occupied by the hammer, the process of lasting a boot would be much facilitated, as the upper could be drawn to its place, the hole made for the peg or nail, and the latter driven in without the necessity of changing tools twice to each nail or peg driven.

CHROMATIC PRINTING-PRESS.

A PRESS for printing in colors devised by F. L. Heughes consists of two or more type-beds arranged on the same vertical line with separate inking apparatus, each of which prints a different color. The cards to be printed are fed between adjustable guides and fall on stops where they receive the first impression from the upper platen and form. The stops are then tripped and the cards fall to the second stops, where another impression is given them. The second stops are now tripped and the card passes out of the press, or to a third stop if more than two impressions are to be given.

ANNEALING AND TINNING WIRE.

WIRE is now annealed and tinned at the Washburn & Moen Manufacturing Company's works, by a process devised by Edwin H. Hill, which consists in running the wire through a vat of melted lead, covered with fine charcoal to prevent oxidation, for the purpose of annealing it, then passing it through a bath of muriatic acid to cleanse it, and next into a bath of melted tin to coat it, so that the wire is annealed, cleaned, and turned at one continuous operation.

A NEW GUNPOWDER, alleged to have several advantages over the ordinary mixture, is made by Messrs. Fuchs & Clement, by mixing six parts of saltpeter, one and one eighth parts of sulphur, one part of charcoal, one and a quarter parts chlorate of potassa, and five-eighths of a part of ground tortoise or turtle-shell.

MANUFACTURE OF GLUE.—Messrs. H. & C. McDougall state that the water of condensation produced in rendering lard by steam (usually thrown away) contains from fifteen to twenty per cent. of glue in solution. They propose to utilize this gelatinous matter by evaporating in any suitable apparatus, and then drying the glue stock thus formed in the ordinary manner.

FIRE-ARMS.—To facilitate the use of either central or rim-fire cartridges in the same weapon, Franklin Wesson proposes to attach to the hammer a false nose, having two striking surfaces, either of which may be brought to bear by changing a pin.

PAVEMENT.—A new floor or pavement, suggested by John Moffet, consists of metallic plates having recesses in which plugs or disks of rubber are inserted to prevent slipping. Instead of metal plates, stone or other materials may be used to receive the rubber.

UTILIZING PAINT-SKINS.

A LARGE amount of paint is thrown away in the skins that form on paint left standing for any length of time, and W. T. Burrell therefore suggests that these skins may be utilized by the following process: Soak one hundred pounds in a solution of two gallons of water, and ten pounds of potash, then boil until the skins are dissolved, and add five pounds of silicate of soda. Then mix ten pounds of whiting in one gallon of linseed oil and add to the previous compound, and grind when cool. A good paint is thus made. Any pigment may be added to change the color.

ARTIFICIAL STONE.—It is stated by C. J. Bandman that a good artificial stone may be made by grinding iron slag into a fine powder, then mixing it with a plaster of common lime until a stiff paste is made. This mixture should be thoroughly incorporated with a proportionate quantity of sand, and then one eighth of the bulk of hydraulic lime added.

TRIPOLI FILTER.—A new material for filters, suggested by W. C. Pettijohn, is solid tripoli formed into vessels of such shape as to hold the liquid and allow it to percolate through the sides.

SEASONING LUMBER BY PRESSURE.—It is stated by J. F. Gyles that lumber in the form of boards, planks, etc., may be rapidly seasoned by being passed between rollers under considerable pressure, which will not only drive the moisture out, but will make the fibres more compact.

MAKING RUBBER EMERY WHEELS.—These articles are usually made of a compound of rubber, sulphur and emery ground together, but the mixture is not sufficiently homogeneous when prepared in this manner, and T. J. Mayall therefore suggests that the rubber and sulphur shall first be dissolved in naphtha or some other good solvent, and then the emery be incorporated with it.

FILTERING GELATIN.—To produce a light-colored size suitable for the whitest paper, N. J. Wells proposes to run hot size, gelatin, or glue through boneblack.

MOTH PAPER.—To prevent the attacks of moths on carpets, clothing, etc., Seymour Crane proposes to prepare paper which may be used for lining carpets, or as wrappings for clothing, by applying to its surface, when in the pulpy state, powder or fibres of tobacco, or cedar-wood either in the form of fibre or saw-dust. Or, if preferred, the paper may be coated with a paste and the tobacco or cedar scattered over.

AGRICULTURE, BOTANY, AND HORTICULTURE.

CLOVER SICKNESS.

By J. H. Gilbert.—If red clover be repeated at short intervals on the same land, the crop soon fails, and the land is said to be "clover sick." After changing the crop for some years, the land regains its power of growing clover. Mr. Lawes and the author have made field experiments since 1849 upon the cause and cure of clover sickness, but as yet with only negative results. When land is not clover sick, manuring with potash salts and phosphates considerably increases the crop, but this manure does not prevent clover sickness. All applications of mineral, organic, and nitrogenous manures have failed in preventing clover sickness. The field is, however, at present rather less clover sick on those parts which received most of these descriptions of manure in bygone years. In 1864, and again in 1867, portions of the field were deeply dug, and a mixture of cinereal manures and nitrate of soda incorporated with the soil, in some cases from a depth of 3 feet upward, but no benefit as yet appears from this manuring of the subsoil. In striking contrast to these failures, red clover has grown luxuriantly on the soil of an old kitchen garden since 1854, and shows no signs of falling off. In 17 years there has been removed from this plot in the form of clover more than 1 ton of potash, and 1¼ tons of nitrogen per acre, without any manure being applied.

These facts offer a wide field for hypothesis. The author thinks that the restorative effect of time may perhaps be owing to the formation and distribution of nitrates and salts of organic acids, while the cinereal plant-food may also assume a condition more favorable to assimilation.(35)

GROWING CELERY.

In growing celery the plants are frequently tied up with rags, hay-ropes, etc., to protect them from unduly spreading and becoming green. As a handy substitute for these materials, John Simpson proposes to use a collar of stiff paper, one end of which has a hook, and the other a series of holes. This collar is put around the plant with the hook in one of the perforations, and as the celery grows the hook tears from hole to hole, so that the collar always expands with the plant, and yet remains securely around it.

MANURING WITH LAHN PHOSPHORITE.

THE great deposit of phosphorite in the district of Lahn is found to be unsuited for the manufacture of superphosphate of high quality, the large amount of ferric oxide and alumina it contains causing the phosphate made soluble by acid to revert to an insoluble condition. Dietrich advocates the application of such phosphorites in a state of fine powder without previous treatment with acid. The solubility of the phosphorite is very small. Water saturated with carbonic acid dissolved in twelve weeks the following grams of phosphoric acid per 100 litres: Lahn phosphorite, best quality, 2.55; a lower quality, 1.66; Baker guano, 12.00; bone-dust, 16.72; precipitated tricalcic phosphate, 27.52. Large quantities of phosphorite may, however, be applied for the same price as small quantities of superphosphate; the action of the weather will also soften the phosphorite considerably, and the solvent power of the organic acids of the soil is probably not unimportant. The author quotes successful field experiments with ground phosphorite, and recommends extensive trials of large dressings of finely-ground phosphorite mixed with sawdust, turf, or other organic compost.

BEST TIME OF HARVESTING FLAX.

A PORTION of a uniform crop, grown in pots, was harvested when the seed-capsules began to turn brown, and only one third of the stalk had become yellow; the remainder was harvested 17 days later, when complete ripeness had been reached. There was a considerable gain in weight of the stalks and branches during the 17 days of extra growth, but the fibre was of inferior quality. The seed gained very little weight during the same period, but both its absolute and percentage contents of oil increased very distinctly. The same increase of oil in the seed was observed in a portion of the unripe crop which, after harvesting, was kept 14 days before the seed was removed; the seed in this case lost weight, while it gained in oil; there was apparently, therefore, a transformation of the contents of the seed into oil.

IN SOWING SMALL SEEDS it is difficult to see whether they are distributed evenly over the soil, as the two are frequently nearly of a color. As a means of overcoming this, J. E. H. Claussen suggests that the seeds be moistened and then covered with flour or some other white substance. This would facilitate their even distribution, and the covering would act as a fertilizer and give the seeds an early start.

A CHEAP FERTILIZER.

IT has been suggested by Samuel Brown that a fertilizing material of considerable value may be made by placing wood and earth in alternate layers in a kiln and burning it. The wood may be "brush" or other material that would be of no value for any other purpose, and the kiln should be so arranged as to allow of the combined ashes being removed from the bottom, and replaced with layers of fresh earth and wood at the top.

AUTOMATIC FEED-BOX.

To avoid the necessity of visiting the stable when the animal has to be fed, B. B. Ruggles suggests that the usual allowance for a meal be set in a box having its bottom hinged at one side and fastened at the other by a catch, which is liberated at the proper time by a lever operated by an attachment to the hour-shaft of a clock, and the feed allowed to fall in the manger. The attachment to the hour-shaft is fastened by a set-screw, so that the catch may be liberated at any desired hour.

HAY AND GRASS.

IT is known that pastures often differ considerably in their fattening properties; it is also well known that hay has a lower nutritive value than fresh grass. It appears that grass differs from hay (the fully-matured product) by containing more of mineral matter, albuminoids, and fat, and less of woody fibre; while both the albuminoids and extractive matter of grass are present in a more soluble form than in hay. Hay made from the autumnal cutting approaches grass in composition.

INFLUENCE OF VEGETAL MOULD ON SOILS.

BY TH. SCHLOESING.—The porosity of soils could not long be preserved if the mineral dust were not agglutinated into granules by some substances acting as a cement, such as vegetal mould, or clay coagulated by lime salts. In light soil, vegetal mould, by means of its humates, consolidates their particles; in heavy ones, by its organic debris, it destroys their solidity and impenetrable character, in both cases maintaining for some time the porosity of the soil.

MANURE ATTACHMENT FOR HARNESSES.—To save manure and to prevent its loss in the street by horses in harness, Elick Berlinger proposes to attach an excrement receptacle to the back band and breeching to receive the droppings.

THE POTATO DISEASE.

AFTER reviewing all that has been said on the subject, the only direction in which there seems to be any reasonable hope of relief from the injury and anxiety produced by this constantly recurring scourge, is in obtaining and cultivating early-maturing kinds. August is the month in which the potato disease seems to do its worst, especially if the weather be both wet and warm. If the crop can be safely housed before this period, the evil will have been evaded, if it can not be cured. The production of early kinds is, with the skill and patience which cultivators bring to the systematic improvement of the potato, only a question of time. (10)

STORING POTATOES.

J. W. BOYES says: The plan that I have adopted, with invariable success, during the last eight years, has been, to sprinkle the floor where I intended keeping them with fine, unslacked lime, over which I spread a layer of potatoes, four or five inches in depth; I then sprinkled again with lime, and added another layer of potatoes the same depth as before, and thus continued till the whole were disposed of. The lime I use is about one fortieth part by measure of the potatoes.

I have found that potatoes thus treated have never become infected with disease, and when disease was already existing it has not spread; besides which, the quality of the potatoes has been rather improved than otherwise by the treatment, especially where they were watery or waxy.

PRESERVING GRAIN IN VACUUM.

DR. LOUVEL.—A series of experiments made on the large scale with the view to try the practical value of the author's process for preserving grain, ship-biscuits, and flour, and especially also preventing these articles being damaged by insects, rats, and mice, by placing the same in strongly-made iron (boiler-plate) vessels of sufficient capacity to contain 27 bushels of grain or flour, and next, after having hermetically closed the man-hole of this vessel, producing a vacuum in it by the aid of an air-pump, it being sufficient for practical purposes that the vacuum be a reduction of about from one sixth to one seventh of the ordinary atmospheric pressure. The result of these experiments (sufficient time having been amply given to test their real value) is satisfactory in every respect. The cost of the apparatus, including air-pump, gauges, tubing, and fittings, is about £64, but one air-pump can be used for a number of these vessels. It should be observed that

the quantity of grain lost or rendered unfit for human food by the ravages of insects, rats, mice, worms, etc., amounts on an average to fully 13 per cent of a crop, while, moreover, by this mode of preserving, much labor required for shoveling grain about in the granaries is rendered unnecessary.

REAPING-MACHINE TRIALS.

A COMPETITIVE trial was made during the summer at Brampton, England. An influential committee was appointed, the judges selected being Mr. M'Kinnell, of Dumfries; Mr. Dods, of Pexham, Northumberland, and Mr. Little, of Fauld, Longtown; and no fewer than forty-three machines by the principal manufacturers in England, Scotland, and America were entered for competition. The machines were divided into three classes; but the great interest centered in the self-delivery reapers, which, from their independence of manual labor (requiring only the driver), are far superseding the manual delivery-machines. The trials commenced in a sixty-acre field of oats, the land being rather hilly, and the crop much laid. The judges selected five of the machines for further trial. On the following day, these selected machines underwent a more extended trial. Toward the conclusion it was evident that the first prize lay between the "International" reaper of Messrs. Howard, of Bedford, and the American machine invented by Messrs. Kirby, of Auburn, New-York State. The final test, however, was cutting a tangled and twisted crop, which the Howard "International" machine accomplished without difficulty, the American Kirby choking. The first prize was, therefore, unanimously awarded to Messrs. J. and F. Howard, Bedford, and the second to the Kirby machine. The trials were attended by all the leading agriculturists of the district, and the interest manifested in the proceedings was sustained to the end. (61)

HAY VENTILATOR.

THIS consists of a wrought-iron tube, about three inches in diameter, which is long enough to reach into the middle of the stack, and, like the Norton well-tube, is provided with a conical point at the tip, and pierced for about two thirds its length with numerous holes. A screw arrangement is affixed to the posterior extremity, by which it can be connected with an accompanying discharge-pipe.

For use, this apparatus is to be driven horizontally into the stack to be investigated, either by means of a mallet or by a screw arrangement, and the temperature ascer-

tained after a short interval by introducing a self-registering thermometer. Should the temperature be too high at any point in the stack, a tin tube is to be affixed vertically to the outer end of the iron tube, and an outward current of air from the interior of the stack produced, by means of which the heat is speedily carried off without any injury to the stack. Hooks may be attached to the tip of the instrument, by which small samples of the central part of the stack can be brought out.

WHEAT IN CALIFORNIA.

CALIFORNIA promises to become one of the great wheat-producing States of the Union. Owing to the absence of rain during the summer and fall, the wheat crop matures perfectly, and after harvesting becomes so dry that it may be shipped to any portion of the world without danger of injury from dampness. With a small population—some six hundred thousand souls—the State is estimated to have produced last year thirty million bushels, worth more than thirty million dollars. (10)

CARTHUSIAN PINK AS A FODDER.

THIS plant often grows in flower-gardens, is eaten readily by animals, and appears to be of high nutritive value. With a strong soil, and well manured, the produce is abundant. The analysis given below is that of the air-dried plant harvested before blossoming.

Water	12.44
Albuminoids	15.32
Fatty matter	3.45
Non-nitrogenous extractive matter	46.34
Crude fibre	12.08
Ash	10.37
	100.00

CLEAN AND DRY STABLES.

A HORSE will endure severe cold weather without much inconvenience, so long as he is furnished with a dry stable. But require him to stand on a wet and foul floor, and his health will soon begin to fail. Horses often suffer from cold feet and legs. A great many stables have damp and wet floors. Few men who handle horses give proper attention to the feet and legs. Especially is this the case on farms. Much time is spent of a morning in rubbing, brushing, and smoothing the hair on the sides and hips, but at no time are the feet examined and properly cared for. Now, be it known, that the feet of a horse require more care than the body. They need ten times as much, for in one respect they are almost the entire horse. All the grooming that can be done won't avail any thing if the

horse is forced to stand where his feet will be filthy. In this case the feet will become disordered; and then the legs will get badly out of fix; and with bad feet and bad legs, there is not much else of the horse fit for any thing. Stable prisons generally are very severe on the feet and legs of horses; and unless these buildings can afford a dry room, where a horse can walk around, lie down, or roll over, they are not half so healthy or comfortable to the horse as the pasture, and should be avoided by all good hostlers in the country.

HUANO MANURE.

AN important improvement in the manufacture of artificial guanos, the discovery of which affords for many cases a practical solution of the difficulty of disposing of sewage, has just been announced in Great Britain, having reference to a substance called Huano manure. This material, it is claimed, is as rich as Peruvian guano, and its manufacturers furnish a guarantee to that effect. It is worth, according to the scale of fertilizers, from $40 to $45 per ton, although its first cost, as manufactured, is less than $13 per ton. In the course of inquiries leading to the invention in question, it was first ascertained that Portland cement transforms night-soil into stone, which, upon being crushed, gives 18 per cent of phosphate of lime; and when applied as a manure for growing turnips, it has produced 26 tons to the acre. Owing to the insoluble nature of the phosphates, however, the action was slow, and the next step in the process was to utilize this property of cementation in the superphosphate manufacture, in which night-soil is substituted for water in the decomposition of the phosphates. During this process the phosphates part with the two portions of their lime, uniting with sulphuric acid to form sulphate of lime, (plaster of Paris,) from which is derived the valuable property of cementing night-soil from a liquid into a solid mass. This solidification produces simultaneous deodorization, removing all offensive and foul effluvia, as well as any capability of giving out deleterious gases, and such powers of destruction are transformed into fertilizing endowments. It will thus be seen that cementation lawfully usurps the place hitherto occupied by fermentation and evaporation, and hydrates all the moisture—which, being chiefly urine, possesses manurial value to the last drop—together with the incorporation of the whole of the ammonia, alkaline salts, and other valuable constituents existing in the night-soil.

The inventor, Mr. Hughan, has made arrangements with

an extensive manufacturer of superphosphates to carry on the process, and great expectations are expressed as to the value of the results to be anticipated. The advantages of working the new patent in connection with such a manufacture, are: 1. The night-soil gives that pasty condition to phosphates essential to the reception and dilution of the acids employed in superphosphate manufacture. 2. The phosphates are increased one fourth in quantity from the alkaline phosphates and phosphoric acid of the soil; thus, if 75 units of phosphate of lime are introduced, 100 are withdrawn. 3. The phosphates receive a new supply of nitrogen equal to from 2 to 4 per cent of ammonia from the soil. 4. The phosphates obtain 5 to 8 per cent of alkaline salts, containing 1 per cent each of magnesia and potash, from the soil. 5. The phosphates receive, in addition, 16 per cent of organic matter intermixed with the urea and uric acid, possessing the latent quality of evolving ammonia to the last atom, and inducing nitrification, as well as the ammonia and nitrates as returned in the analyses. On the other hand, night-soil receives from phosphates the following advantages: (*a*) Cementation; (*b*) solidification; (*c*) deodorization; (*d*) portability by rail or sea in the service of agriculture; (*e*) the bringing within the pale of sanitary laws, contributing to health and to municipal revenues. It is even suggested that the present superphosphate manufacture must ultimately pass over into night-soil utilization, either voluntarily or by legislative enactment.

REDUCING BONES.

In the discussion of wheat-culture, at a late agricultural convention in Newport, N. H., Mr. Pattee, of Warner, gave a formula for reducing bones, as follows: Place them in a large kettle filled with ashes, and about one peck of lime to a barrel of bones. Cover with water and boil. In twenty-four hours all the bones, with the exception, perhaps, of the hard shin-bones, will become so much softened as to be easily pulverized by hand. They will not be in particles of bone, but in a pasty condition, and in an excellent form to mix with muck, loam, or ashes. By boiling the shin-bones ten or twelve hours longer, they will also become soft. This is an easy and cheap method of reducing bones. If the farmer will set aside a cask for the reception of bones, in some convenient place, and throw all that are found on the farm into it, especially if one or two dead horses come into his possession, he will be likely to find a large collection at the end of the year, which would prove a valuable adjunct to the manure-heap.

BEET-LEAVES FOR FODDER.

MÉHAY maintains the entire success of his method of so preparing the leaves of the beet as to render them capable of preservation for several months as fodder, and at the same time greatly improving their quality as food for cattle. The method consists simply in placing them in baskets and immersing them in a tank containing diluted hydrochloric acid of 4° of Beaumé. The result of this is to greatly condense the volume of the leaves, and to render it necessary to add more fresh ones to fill up the basket, which has to be again immersed, and finally allowed to drain off. The leaves may then be placed in beds, in dry earth, and kept until needed for use. According to a report of a committee who examined the results of this process, domestic animals become extremely fond of the leaves thus prepared; and, indeed, milch cows fed with them are said to give a large increase of milk, with a decided improvement in the quality of the butter. The tendency to diarrhœa in cattle produced by the fresh beet-leaves seems not to be developed by this prepared fodder, and for this and many other reasons it is strongly recommended to agriculturists.

RUSSIAN SUMMER-RYE.

BY F. SCHWACKHÖFER.—This appears to be a little known variety of rye. Its produce is great, and remarkable for the high percentage of nitrogen present, and for other peculiarities. The weight of the corn per bushel was 68 lbs. The percentage composition was as follows:

	Corn.	Straw.
Water	12.90	10.79
Albuminoïds	17.34	4.60
Fatty matter	2.54	1.83
Non-nitrogenous extractive matter	62.46	23.38
Crude fibre	2.66	53.92
Ash	2.10	5.48

The ash yielded to analysis the following percentage results:

	K_2O.	Na_2O.	CaO.	MgO.	Fe_2O_3.	P_2O_5.	SO_3.	SiO_2.	Cl.
Corn..	34.20	1.45	trace.	12.40	trace.	50.99	trace.	1.01	trace.
Straw..	30.84	.39	7.66	1.99	trace.	4.90	5.64	48.50	trace.

FUNCTION OF POTASSIUM IN SOILS.—According to Nobbé, the presence of potassium in soils is necessary in order to enable the chlorophyll grains of the leaves to form starch, sodium and lithium being unable to replace potassium in this function, the latter indeed being actually injurious. He has also ascertained that the different combinations of potassium vary very much in their value, the chloride being by far the most efficacious.

SEEDS OF WEEDS.

IT has been estimated that one plant of the red poppy bears 50,000 seeds; one sow-thistle, 19,000; one corn-cockle, 2590; the charlock, 4000; a groundsel, 6300; and the black mustard, 1200. Old gardening-books recommend any person who enters a garden to pull up whatever weed he saw near him. If he is a benefactor of his race who causes two blades of grass to grow where but one formerly flourished, the man who pulls up only one weed has at least equal claims on our respect. He sets free a large space of land for useful cultivation.

INJURIOUS INFLUENCE ON VEGETATION OF THE FUMES FROM SMELTING-WORKS AND COAL FIRES.

BY A. STÖCKHARDT.—The author describes in detail the destructive effects of the Freiberg lead-smelting works. In the vicinity all vegetation was destroyed, and a pine forest at the distance of four miles was considerably injured. Cattle feeding on the fodder of the district suffered special sicknesses. Analysis showed that the affected plants contained traces of arsenic and lead, and an abnormal quantity of sulphuric acid. Experiments were made as to the cause of injury.

Young fir-trees in an open garden were covered by a suitable case, and subjected to a known fumigation for two hours; the case was then opened and free access of air permitted. Eighty-six such fumigations with the vapor of arsenious oxide produced no effect on the tree. Vegetation is not destroyed in the neighborhood of arsenic factories. When arsenic is applied in solution to the roots of plants, it is far more prejudicial. Finely-powdered lead carbonate was dusted from time to time on a young fir during one year; there was no growth during this year, but in the next season the tree was healthy and vigorous. Sulphurous oxide proved most destructive. Five fumigations with air impregnated with $\frac{1}{1000}$ volume of this gas caused all the leaves to fall, and killed the upper part of the tree. Excessively dilute atmospheres produced equal injury when applied for longer times. Fir-trees placed in a room and treated with 335 fumigations of $\frac{1}{10000}$, extending over three months, were quite killed; the trees kept moist were first affected. Soot appeared to be quite innocuous. Benzine was burnt under the case; it remaining a young fir till the tree became quite black; it nevertheless produced its annual shoots, and remained quite healthy. The author concludes that sulphurous oxide is the poisonous ingredient of the smoke from smelting-

works. The injury from this cause is less than formerly, as the sulphurous oxide from roasting ore is utilized for the manufacture of oil of vitriol.

Handtke and Freytag have experimented on field-crops. In an atmosphere containing $\frac{1}{33000}$ sulphurous oxide, the destruction of the chlorophyll-grains in wheat, oats, and peas, appears in a few hours; but, curiously, in a dilution of $\frac{1}{77000}$ no injury takes place. Cabbages, and all plants having large strong leaves, are less affected. The fir tribe are far more susceptible to sulphurous oxide than deciduous trees; of the latter, white-thorn, beech, birch, and fruit-trees are most affected; poplar, alder, and mountain-ash least.

Wood-smoke has no injurious effect on vegetation, but the smoke of coal and of some kinds of turf is very prejudicial; the injury is due to the sulphurous oxide produced on combustion. The leaves and twigs of trees poisoned by coal-smoke contain an abnormal amount of sulphuric acid. (32) (89.)

VEGETABLE FIBRE.—The following process for making fibre and paper pulp from the leaves of the family of plants known as *Typha Latifolia* (in English, bulrush) is described by Jonanen Dupont: The plants are first cut and dried, then steeped for six days in water containing for each five hundred parts of the latter, ninety-five parts of quicklime and five parts of sulphur. They are then washed and beaten to free them from gummy or other objectionable matter. If white silky fibres are desired, they are boiled in an alkaline solution, bleached, and finally washed in clean water. The long fibres thus produced may be used for rope-making, or for spinning and weaving, and the short fibres unfit for these purposes may be made into paper.

STARCH IN POTATOES.—In sixty-one varieties, English, French, and German, the proportion of dry substance was found to vary from 16 to 34, and that of starch from 9 to 26 per cent.

A METHOD of preserving seed-potatoes, practiced in New-Zealand, consists in stringing them, by means of a large needle and twine, then hanging them up in dry rooms. (10)

BROOM-CORN.—It is stated by Solomon Greger that broom-corn may be made much tougher and more durable by subjecting it to treatment with boiling water or steam, and that an inferior corn will be made as good as the superior article when not so treated. For fancy brooms, whisks, etc., the corn may be dyed at the same operation.

MANURING WITH STRAW.

BY C. E. BERGSTRAND.—Superfluous straw is easily converted into manure by rotting it in heaps with a little rape-cake or other ferment. Manure so prepared contained:

Water.	Organic matter.	Ash.	Nitrogen.	Phosphoric acid.	Potash.
74.36	15.63	10.01	.23	.10	.17

Compared with good dung, it is deficient in nitrogen phosphates, and potash. If to 12,000 lbs. of such manure 100 lbs. superphosphate and 100 lbs. ammonium sulphate be added, it will equal the best dung; same in potash.

NEW USE FOR CORN-STALKS.—A new filling for mattresses, suggested by B. Harrington, consists of cornstalks crushed between rollers and then subjected to the action of a picking machine, by which they are reduced to fine shreds.

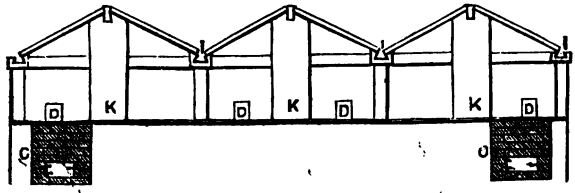
ACCORDING to Unger, a water-surface evaporates about three times as much as a plant of the same surface, and a forest in leaf evaporates much more than even a water-surface; T. Harting, on the contrary, states that the evaporation from a forest is less than that from water or naked earth. Dalton estimates the annual dew-fall in England at 5 inches. Lavayssée found the dew at Trinidad, from December 2d to May 1st, to amount to 6 inches; he collected it on sponge. Little is known concerning the amount of water absorbed by soils from the atmosphere; according to W. Knop, indeed, it exceeds the rainfall; but more investigations are needed.

LOW VERSUS HIGH FRUIT-TREES.—An Illinois fruit-grower, who has 12,000 apple and from 4000 to 6000 pear-trees, finds that "those with low heads of the same varieties show at least two thirds more fruit, as large or larger, and as high colored as those with high tops." To test the matter, he cut off in certain rows all the limbs from 4 to 6 feet from the ground, and in others encouraged the limbs to start close to the surface, and in the latter case neither thinned nor pruned, except occasionally to lop away a too lusty shoot in order to preserve a symmetrical appearance or an evenly balanced head; and the above is the result.

DESTROYING CATERPILLARS.—According to Schmidt, an excellent remedy against caterpillars consists in a dilute solution (1 part in 500) of sulphide of potassium, the infested tree being sprinkled with this substance by means of a small hand syringe. This method has been used on a large scale in France, and, it is said, without any injury to vegetation.

HINTS ON CHEAP GREENHOUSES.

BY PETER HENDERSON.—The cheapest kind of construction is a lean-to, that is, where there is any thing to lean it against, such as the gable of house or barn. But if the greenhouse has to be constructed entirely new, I think the ordinary span-roof is best—see end-section. The walls are four feet high, formed of locust or cedar posts. To the outside of these are nailed boards—rough hemlock will do, if appearances are not considered. To the boards is tacked the ordinary tarred paper used by roofers—a cheap article, and an excellent non-conductor of heat. Against the paper is again nailed the outer or weather boarding. This makes really a better wall for greenhouse purposes than an 8-inch one of brick, as we find that the extremes of temperature of the greenhouse —inside at 50°, and perhaps 10° below zero outside—very



soon destroy an 8-inch *solid* brick wall, particularly if exposed to the north or west. A wall of wood constructed as above will last for twenty years, and be as good a protection as one of 8-inch brick. So much for the construction of the frame. The roof is formed by the ordinary sashes, six feet in length by three feet in width, which can be bought ready made, or easily be made by a carpenter or any one handy with tools.

Such a house, if cheapness is an object, should be heated with a flue. It should not be more than sixty and not less than thirty feet in length; if more, the flue would not heat it enough, and if less it would be likely to get too much heat. About fifty feet by eleven is we think the best size of a greenhouse to heat with a flue. The flue should run all around the house—that is, it should start along under one bench, cross the end, and return under the other bench to the end where it begins, making the length of flue in a greenhouse of fifty feet about one hundred and ten feet long. It should have a "rise" in this length from the furnace of at least eighteen inches, to secure a free draught. For the first twenty-five feet of flue nearest the furnace it should be built of brick, forming an air-space in-

side of about 7 by 7 inches. From this point (twenty-five feet from the fire) the flue should be formed of the ordinary drain-pipe cement or terra-cotta. The former is to be preferred, and that of seven or eight inches diameter is best. The drain-pipe for flues is now almost exclusively in use here wherever flues are used, and it is found not only to be much cheaper, but better for rapid radiation than brick. The cost of a plain greenhouse so built, complete, is, in the vicinity of New-York, about six dollars per running foot—that is, one fifty feet long by eleven feet wide costs about three hundred dollars. (71)

NEW GOLDEN CHINESE JUNIPER.

THE Chinese juniper is one of our best hardy conifers, and well known in English gardens. The variegation is a good golden yellow, and appears in perfectly constant proportions in the plant in all stages, while the growth seems quite free and robust, like that of the green or common form. Like the golden yew, however, it is seen to much greater advantage in spring and early summer than in autumn, though it is certainly most attractive now. We have therefore no hesitation in pronouncing it a most valuable addition to our variegated hardy trees, and worthy of association with the golden yew.

This is a not unfitting opportunity to protest against the bad use frequently made of very striking plants of this character. Their beauty entirely depends on their marked contrast with the ordinary green types of foliage, and therefore to plant them in lines or crowds is to destroy their beauty; yet we have lately seen a ribbon border with the new variegated Negundo in a line at the back, and a noble place in the Midlands hideous from the presence of several thousand golden yews in lines, avenues, etc., as if there was little else in the world worth planting. (45)

ZINC LABELS FOR TREES.—Take of verdigris and sal-ammoniac each two drams, of lampblack one dram, water four ounces, to be well mixed in a mortar, adding the water gradually. It must be kept in a glass-stoppered vial. Write on the zinc with the ink, after shaking it well, with a quill pen; and after it is dry you may expose it to the weather or bury it in the ground for years, and it will be as legible as when first written.

C. F. SMITH suggests the use of a composition, composed of blue vitriol, chalk, and iron scales, to be placed around apple and other trees to exterminate borers and invigorate the trees. (10)

GATHERING CAOUTCHOUC.

ACCORDING to Paul Levy, the harvester of caoutchouc in Nicaragua goes to the middle of the forest to look for caoutchouc trees (*castilloa elastica?*), and when he has found one, he climbs to the top of the tree by the aid of a *gaucho* (a kind of hook), and by means of his gouge makes some zigzag incisions on the principal branches, communicating with each other, to form a kind of general gutter as far as the trunk. The gashes, which go through the bark, are only made on the under side of the branches, but on the trunk they are made all the way to the foot. Some trees give twenty pounds of caoutchouc; the liquid is received in calabashes, where it is coagulated, by simply agitating and leaving to itself. To aid in coagulating, the natives use the stalks of certain branchy plants, which allow their sap to flow down and act as a coagulating agent. Caoutchouc of good quality cannot be obtained from trees less than 14 years old. Unfortunately, the harvesting is done with little care, and the gashes almost always penetrate beneath the bark. A slightly larger yield is obtained, but it is destructive to the tree.

POTASH lye, one gallon; soft soap, one pint; petroleum, one quart; water, one gallon. This is a new remedy by De Moss for borers and other insects on trees. Apply upon the bark, with a swab. (45)

COMMERCE IN POLLEN.—A curious trade has recently sprung up, in a demand for pollen to fructify certain plants. The palm tribe, the *Cycadaceæ*, and other greenhouse trees, will flourish without producing stamens, and, for want of pollen, will not fruit. It is therefore now becoming common to see advertisements for the pollen, for example, of the *Caryota urens*, and other tropical plants, and it is received through the post.

NEW CUCUMBER.—The new white spine cucumber, when raised on a trellis, grows to an enormous size, one vine having three specimens, each of them three feet in length, besides many others over two feet long. The flesh is said to be very solid, with but few seeds, and the flavor very fine. This method of growing cucumbers is recommended as furnishing a much superior result to that of allowing them to trail on the ground, as they thus grow finer, straighter, and with a larger yield. This new cucumber has the skin perfectly smooth. It is very short in the neck, and it is considered a decided gain to the resources of the vegetable gardener.

THE UTILITY OF ODORS TO PLANTS IN RELATION TO RADIANT HEAT.

PROFESSOR TYNDALL, in his lectures, states that he has found that odors or perfumes, in common with many gases and vapors; especially that of water, have the remarkable property of absorbing large quantities of radiant heat; and particularly the obscure non-luminous rays, such as those emitted by the earth. Thus he has shown in his table of the "Absorption of Perfumes," that otto of roses absorbs 37 times as much heat as perfectly dry air. A correspondent of the *Chemical News* suggests that from the above we may infer that a rose-tree in bloom, thus generating around it a warm atmosphere of odor, is ministering to its wants by virtually providing for itself a more congenial temperature than it would otherwise enjoy. Consequently it is concluded that the envelopes of aroma which surround the flowers must materially aid in the maturation and protection of the seed. The odor exhaled by the fronds of ferns may serve as a protection against cold, and also serve to indirectly aid in the fertilization of the spores. (11)

FERMENTATION AND PUTREFACTION.

IT is one of the great attractions of the science of botany, an attraction common to all the other branches of the study of nature, that wherever we may happen to be, and under whatever circumstances, something interesting and suggestive is continually brought before the eye and mind educated to understand its teachings, and no true naturalist ought long to be in a difficulty seeking for a suitable subject for illustration.

The character which most broadly distinguishes the vegetable from the animal kingdom is certainly the power which the former possesses, when taken in mass, of winning over from the inorganic kingdom binary compounds which can not contribute directly to the nutrition of animals, decomposing them, and recombining their elements into organic compounds suitable for the support of animal life. This process—the decomposition of water into oxygen and hydrogen, of carbon dioxide into carbon and oxygen, and of ammonia into hydrogen and nitrogen, and the recombination of these four elements while in a nascent condition into starch, sugar, gum, protoplasm, etc.,—is, so far as we know, carried on in plant-cells containing endochrome under the influence of light, and in such cells and under such circumstances alone. We thus find that this truly vegetable process is performed by a very small portion of an ordinary plant. The cells of the

internal organs of plants and of large pulpy masses, such as pears, connected with the function of reproduction, are perfectly colorless; simple sacs of cellulose, containing in their early condition protoplasm, and increasing and multiplying by its agency; and afterward containing other substances in addition, such as starch and sugar, the products of its assimilation and excretion. These masses of protoplasm with their investing membranes composing the so-called "cells" feed, indeed, upon the ternary and more complex compounds produced by the leaves of the pear-tree, and are aërated by the fluids which are passing through the tissues of the pear-tree; but, secluded from the light, and developing no special coloring matter, their reactions are not in the strict sense "vegetable;" they absorb the organic compounds and breathe the distributed air in the true animal sense, just as *Amœbæ* would do. To take the function of respiration as a test, they absorb oxygen and exhale carbon dioxide, while in the green parts of plants, which alone perform the great function of the vegetable kingdom in keeping up the "balance of organic nature," the exhalation of carbonic acid is in the sunshine entirely masked by the exhalation of oxygen—the product of its decomposition. A green tree may be likened to that wonderful animated tree, one of the oceanic Siphonophora, where a certain set only of the polyps are set aside to feed and supply nutrition for the whole, while others, identical with these in essential structure, feel, or sting, or reproduce the species, or palpitate through the water as locomotive swimming-bells.

We learn from the beautiful researches of M. Bérard that if fruit be placed to ripen in air or in oxygen gas, a considerable quantity of oxygen is absorbed and an equivalent proportion of carbon dioxide is given off; that, in fact, a notable quantity of oxygen is burned in a true process of respiration. It is calculated by De Barry that the number of plants in which chlorophyll is absent—that is to say, which have no power of decomposing and recombining the elements of water, carbon dioxide, and ammonia, and which consequently require to have their food presented to them in the form of organic matter—is fully equal to that of green plants, say 150,000. These plants are chiefly fungi. The part they play in the economy of the organic world is wonderful. The moment a plant gets worsted in the battle of life, becomes delicate from uncongenial soil or other circumstances, or gets smothered by a more vigorous rival, they set upon it and burn it. If we look just now in the Botanic Garden at any of the old summer beds of half-hardy plants, we shall see them shroud-

ed in a maze and network of white fleecy mould. That mould is a fungus finishing the work of extermination which the frost has begun, and then burning the bodies. In all the odd corners there are heaps of rotting vegetation. These stems and leaves are not rotting themselves; heat them to 212° F., so as to kill the seeds of the fungi, and seal them up in closed cases, and although they will slowly decompose, they will never rot. They are being burned by the pro cess of respiration of fungi just as effectually as they would be if they were collected in a heap, dried, and set fire to. Most of these fungi are very minute, but each of them, when it is found in any thing like a well-developed condition, is thoroughly characteristic. Still they are so small and so simple that it is difficult to distinguish parts of those organs whose form is not so strongly marked. WYVILLE THOMSON.

SOURCE OF NITROGEN IN PLANTS.

IT is well known that the quantity of nitrogen contained in the crops exceeds in enormous proportion that existing in the manures, the excess undoubtedly being derived from the air. It is now a question whether this is extracted directly from the air by plants, which would thus have the power of assimilating directly, or if it is first taken from the air by the soil, so as to combine with organic matter and form an assimilable compound. According to Deherain, oxygen, in the presence of organic matter, combines directly with nitrogen to form a compound analogous to the humus of the earth, or to ulmic acid. To illustrate this, he placed in a tube oxygen, nitrogen, glucose, and ammonia. On drying the tube and heating it, a black, nitrogenized matter was left, and a portion of the nitrogen in the tube was found to have disappeared.

VITALITY OF FRUIT-TREE CUTTINGS.

THE Annual Report of the Horticultural Society of the Colony of Victoria gives some facts proving that scions and cuttings retain their vitality much longer than has been generally supposed. The Society had a case of fruit-tree cuttings forwarded to them from the Chiswick Gardens. These cuttings were from among the prunings taken off in the month of October. They were forwarded in December, and reached Victoria in about six months after they were cut from the trees. On their arrival in the month of April, "there being no stocks in condition for grafting," they were kept over for another four months, or until the following August, when they were worked. It will thus be seen that more than three quar-

ters of a year elapsed from the time the cuttings were taken from the parent tree at Chiswick, until they were used as scions at Victoria. Notwithstanding the delay, the result is, that out of the consignment, five vines, eight plums, twenty-four figs, sixty-six apples, and seventy-two pears have been saved.

PRESERVING DRIED FLOWERS IN COLOR.

THE materials required are common cartridge-paper, thick white blotting-paper, cotton wadding and millboard, all cut to the same size. The plants should be gathered in dry weather, and soon after the flowers open, when their colors are brightest. Succulent plants (such as daffodil, orchis, or stonecrop) should be put into scalding water, with the exception of *the flowers*, for a minute or two, then laid on a cloth to dry. Arrange the specimens and papers in the following order: Millboard, cartridge-paper, wadding, (split open, and the glazed side placed next to the cartridge-paper,) blotting-paper; *the specimens* having small pieces of wadding placed within and around the flowers to draw off all the moisture as quickly as possible, blotting-paper, wadding as before, cartridge-paper, millboard. When the specimens, etc., are thus arranged, heavy weights should be put on them: about thirty pounds the first day, sixty pounds afterwards. Remove them from under pressure in a day or two; carefully take away all the papers, etc., *except the blotting-papers between which the specimens are placed;* put these in a warm air to dry, whilst the removed papers, etc., are dried in the sun, or by the fire. When dry, (but not warm,) place them in the same order as before; put all under the heavier pressure for a few days, when (if not succulent) they will be dry. Flowers of different colors require different treatment to preserve their colors. Blue flowers must be dried with heat, either under a case of hot sand before a fire, with a hot iron, or in a cool oven. Red flowers are injured by heat; they require to be washed with muriatic acid, diluted in spirits of wine, to fix their color. One part of acid to three parts of spirit is about the proportion. The best brush with which to apply this mixture is the head of a thistle when in seed, as the acid destroys a hair pencil, and injures whatever it touches (except glass or china); therefore it should be used with great care. Many yellow flowers turn green, even after they have remained yellow some weeks; they must therefore be dried repeatedly before the fire, and again after they are mounted on paper, and kept in a dry place. Purple flowers require as much care, or they soon turn a light

brown. White flowers will turn brown if handled or used before they are dried. Daisies, pansies, and some other flowers, must not be removed from under pressure for two or three days, or the petals will curl up. As all dried plants (ferns excepted) are liable to be infested by minute insects, a small quantity of the poison, *corrosive sublimate*, dissolved in spirits of wine, should be added to the paste, which it will also preserve from mould. The best cement for fixing specimens on to the paper or cardboard is *gum-paste*. It is composed of thick gum-water, and flour mixed in warm water, by adding the two together warm, and of a consistency that will run off the hair-pencil. (16)

THE AGE OF THE SEQUOIAS.

IN his address as President, delivered before the American Association at Dubuque, Prof. Asa Gray referred to the size and age of the far-famed Giant Red-Woods (*Sequoia gigantea et sempervirens*) and the Australian Gum Tree (*Eucalypta*) as follows:

"Some, we are told, rise so high that they might even cast a flicker of shadow upon the summit of the pyramid of Cheops. Yet the oldest of them doubtless grew from seed which was shed long after the names of the pyramid-builders were forgotten. So far as we can judge from the actual counting of the layers of several trees, no Sequoia now alive can sensibly antedate the Christian era. . . . It is probable that close to the heart of some of the living trees may be found the circle that records the year of our Saviour's nativity." This opinion, which may be regarded as authoritative and final, has an important bearing upon certain geological questions, since it goes to prove that the most recent geological changes that have occurred in that region must have terminated at a period prior to the advent of the Christian era.

MESQUITE GUM.

MR. F. KALTEYER, treasurer of the Agricultural and Industrial Association of Western Texas, says the mesquite gum of that region is almost identical with gum arabic, having been in use there for medicinal and technical purposes, especially in the preparation of mucilage, gum drops, jujube paste, etc. The past year it has become an article of export, some 12,000 pounds having been gathered in Bexar county, and as much more between that and the coast. No gum is gathered west of Bexar, though the drought was favorable to a large crop. This gum is hardly known east of the Brazos. It exudes from the stem and branches of a *mimosa*, several species of

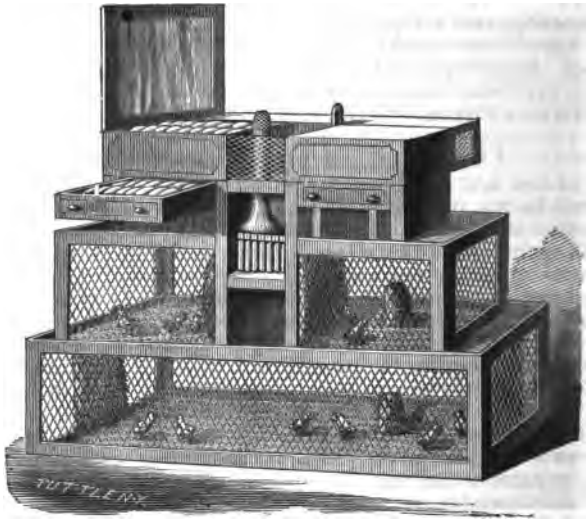
which grow in Texas, New Mexico, and Arizona. One of these species, *Algarobia glandulosa* (Torrey and Gray, N. A. F., 399), is rarely met with below the mountain region of Western Texas. The species most common in Bexar county grows from twenty to forty feet high and eighteen inches thick. From it, charcoal is manufactured. It is generally used for picket poles, being very durable. It is also made into handsome furniture, the grain being very fine. It grows where no other fruit tree would live. It was favorably noticed in the last annual report of the American Pharmaceutical Association.

FERTILIZATION OF THE YUCCA.

At the last meeting of the American Association for the Advancement of Science, Mr. C. V. Riley read a paper on the fertilization of the American yucca, showing that it is accomplished by a small moth, hitherto undescribed, which he called *Pronuba yuccasella*, and which appears to be specially adapted for the purpose. The female only has the basal joint of the maxillary palpus wonderfully modified into a long prehensile-spined tentacle. With this tentacle she collects the pollen, thrusts it into the stigmatic tube, and having thus fertilized the flower, she consigns a few eggs to the young fruit, the seeds of which her larvæ feed on. The yucca is said to be the only plant known which absolutely depends for fertilization on a single species of insect. The plant and its fructifier are inseparable under natural conditions, and the latter occurs throughout the native home of the flower. In the northern parts of the United States, and in Europe, where the yuccas have been introduced, and are cultivated for their showy blossoms, the plant, being deprived of the good offices of this insect, produces no seed. The larva of the *Pronuba*, it should be mentioned, eats through the yucca capsule constituting its food, enters the ground, and hibernates there in an oval silken cocoon. It would, no doubt, be possible to introduce it in foreign countries, and thus secure the fertilization of the yucca.

VEGETABLE HAIR.—As a substitute for curled hair for stuffing upholstery and bristles in brushes, Robert J. Kellett proposes to use the fibres of plants of the magney or cactus family. The stems and stalks are rotted to separate the fleshy portions, then beaten, and dried. If to be used for stuffing, the fibres are curled by passing over hot cylinders, or are spun into ropes; but if to be used for bristles, they are cut up into suitable lengths.

RURAL AND HOUSEHOLD ECONOMY.



INCUBATING MACHINE.

MR. W. H. THICK, of London, has devised the warm-water egg-hatching machines shown in our engraving. These incubators are constructed with a reservoir holding about ten gallons of water. Heat is supplied by gas or by a kerosene lamp, the temperature required for hatching being regularly maintained day and night. Air-carrying pipes pass through the heated water, and carry warmed air to all parts of the hatching apparatus, and hot-water boxes form part of the reservoir, under which the chicks, when hatched, are placed to receive the heat necessary for their health. The boxes are covered with a lamb-skin or a "wool-mother," against which the chickens nestle their backs, while the cool, graveled flooring affords for their feet a surface similar to that which they would have had they been naturally hatched. It is calculated that, if proper attention be paid to the instructions, seventy per cent, at least, of strong, healthy birds may be hatched out.

The drawers of the incubators should be strewn with

bran or hay cut into small pieces, but never with sawdust, as the turpentine in the wood tends to destroy the germ in the egg.

We spread a quantity of hay upon the bottom of the drawers, so as to line them completely, and we place fifty hens' eggs in each drawer on the hay, and close the drawers. Heat is communicated from the water in the reservoir, the temperature of which must be about one hundred and twenty degrees Fahr., in order to have the eggs at the required temperature of one hundred and two degrees to one hundred and four degrees.

Twice every day the drawer is opened to turn the eggs, and they are then left exposed to the cooler air of the apartment for a quarter of an hour before being replaced in the machine. When we add that the position of the eggs in the drawer may also be changed three or four times a day, we have given all necessary directions. After an incubation of twenty-one days, the chickens will break their way out of their shells. They are then left for four-and-twenty hours after they are hatched under the "wool-mothers," to dry and gain strength. During this time they are better without food, as the nourishment they have taken before breaking the shell is sufficient to serve them for that period.

The system of chicken-rearing we have described is admirable for the careful observation of natural processes upon which it is based. Nature has been copied with the most perfect tact, and it is owing to the faithful imitation of her operations and conditions that success has been attained. The reservoir with its flannel covering represents the sitting hen, and the heat that proceeds from the reservoir is of the same temperature and almost of the same nature as the moist heat which emanates from the body of the parent bird.

The hen on her nest warms her eggs from above, and the incubator is so constructed as to supply the heat from the same direction. The hen turns her eggs once or twice a day, removing those that are in the centre of the nest to the outside, and those that are on the outside into the centre, so that an equable heat is diffused throughout. This operation on the part of the parent bird may easily be traced by marking the eggs with pencil, and arranging them in a certain order before the sitting commences. In using the incubator, the same process of shifting and turning is strictly observed. The hen quits her eggs once or twice a day, for a few minutes—about a quarter of an hour—in order to take the nourishment necessary to sustain life, and thus the eggs are allowed to cool to some

extent during the interval, the variation of temperature being considered favorable to the process of incubation. In using the incubator, we take out the drawer, and expose the eggs to the air of the room, thus imitating the natural process in every minute particular.

Timid hens are bad sitters, and if from any sudden alarm a shock is given to the eggs, the hope of chickens may be considered as gone forever; but in the case of the incubator, with its softly-lined drawers, the eggs are not injured, though the apparatus is kept in a workshop in which the din of the hammer is continually heard.

With regard to the economical advantage of using the most improved hatching apparatus, we have to inquire what is the cost of the grain consumed by a hen hatching fifteen or sixteen eggs only, compared with the cost of the oil or gas required to maintain the temperature in an incubator hatching one hundred or two hundred eggs. Experiment proves that the artificial heater costs about two pence every twenty-four hours, so that the expense of hatching the brood of from one to two hundred is under four shillings. In summer, when the temperature of the atmosphere is naturally high, the expense is considerably less. On the other hand, the brood hen is not fed at a less expense than one penny *per diem*, and at this rate no more than thirty eggs are hatched naturally, at the outlay which, by using the incubator, will insure the hatching of two hundred. Besides this evident advantage, it is to be remembered that in artificial hatching the mother bird is free to continue laying uninterruptedly—thus paying its own way.

When the chickens are hatched, dried, and covered with down, at which condition they will arrive about two-and-twenty days after incubation, they are placed under the "artificial mother." The water boxes being properly heated, are covered with lambskin, under which the chickens shelter and warm themselves. In this *nursery* they are kept and fed for about a week; they are then let out, but still kept near the nursery, the runs of which remain open, so that they may enter when alarmed, or when called to feed.

WATER-PIPES.—It is stated by J. W. Brown that a cheap yet efficient water-pipe may be made by laying in a ditch a trough of burnt clay, or other material, and inclosing therein a tube of the same substance, which is surrounded with cement contained in the trough. The trough and tube should "break joints," and the cement binds both together.

INFLUENCE OF COAL-GAS UPON VEGETATION.

By Dr. Virchow.—The author gives a detailed account of a series of experiments made, at the request of the municipal government of Berlin, by himself and a committee of scientific men, for the purpose of elucidating the question whether the infiltration of coal-gas, in the soil whereupon plants and trees are grown, is or is not injurious to these. The result of the carefully-conducted researches is that coal-gas is an active poison to vegetation, and that trees, shrubs, and ornamental plants are killed by it.

PRESERVATIVE FOR MILK AND BEER.

By A. Hirschberg.—It appears that there has been for sale for some time in Sweden, under the name of aseptin, a mixture consisting of equal parts of boracic acid and alum, this mixture being applied for the preservation of meat, and also for protecting it from the injurious action of the oak-wood of the casks in which it is kept. The author states that he found that, by adding 1 grm. of boracic acid to 2 pounds of milk, it remained sweet and fresh in hot summer weather for 120 hours, while the milk not so treated became sour and quite useless in 36 hours. The addition of boracic acid to milk does not interfere with its use, but the cream is separated far more slowly. Experiments have shown that beer is improved by the addition of boracic acid, even if it is kept at a comparatively high temperature.

HARNESSING HORSES.

A new method of arranging the lines in double harness has been suggested by J. Murray, who attaches a line to the outside of each horse's head in the ordinary manner; but, instead of connecting the inside lines as usual, each of them is attached to the trace of the opposite horse. By this arrangement, it is claimed, a pair of horses not accustomed to work together can be used with perfect ease, as, should one pull faster than the other, the short line, being connected to the other one's trace, will have a tendency to hold the first one back, and they will thus soon pull evenly together.

Wheat mixed with lactic acid has been suggested as a new article of food by M. H. Kollock, who first roasts the wheat, then keeps it for six hours at a temperature of about 220° Fahr., and then mixes the acid with it in the proportion of about one part by weight to ten of wheat.

According to Pasteur the application of heat tends to improve wine.

LINING WELLS.

A WELL-LINING devised by William M. Campbell consists of cylinders of terra-cotta of smaller diameter than the bore of the well, the space between being filled in with coarse gravel. The bottom section is closed, except for small perforations to admit water, and on this the bottom of the suction-pipe stands. The upper section is in the form of a cone with a hole for the passage of the pipe through it, which hole is made rather larger than the pipe, to admit of ventilation, but is covered with a perforated cap to prevent the entrance of vermin.

PREPARING FISH.

A PROCESS for softening the bones of menhaden and other fish, for preservation as food, has been devised by I. L. Stanley, which consists in placing the fish, after being cleaned, in open vessels, which are then set in a steam-chest, and the contents subjected to the action of steam at about 212° Fahr., for five hours, after which the fish are removed, drained, cooled, and packed with oil in metal boxes of marketable size, which are then closed and soldered, after which the closed boxes are heated by steam at from 217° to 220° Fahr. for about five hours, according to the size of the fish or bones. By this mode of preparation, the fish may be duly preserved without vinegar or spices.

SALT FISH.

THE following suggestions with regard to keeping and preparing pickled mackerel and other salt fish are by Mr. Isaac Hale, of Newburyport, Mass., who has more than a merely local reputation as a packer of fish, and as an "expert" on all matters thereto pertaining:

To keep mackerel nice, and prevent rusting, be sure that they are kept under the pickle. If the pickle should get below the fish, fill up with more made by putting salt in cold water. The cellar, or some place in which you have no fire and an even temperature, is the best place to keep all kinds of pickled fish.

For boiling, soak 24 hours; for broiling or for baking, soak 48 hours. In the latter case, cream or milk can be used for cooking them in. To avoid the unpleasant rising up in the throat after eating, which many persons experience, skin the mackerel before cooking, and a white, pulpy substance will be found, which adheres to the skin, and which causes this strong taste.

Dry codfish should never be boiled, as the flesh is harder the more it is boiled. Strip up fine, then soak in cold water until quite soft, and before bringing to the

table change the water, and put over the fire and just bring to a scald, and it is ready for use. After preparing dry fish in this way, turn the water off, add a small piece of butter, and a milk or flour gravy, and you have an excellent breakfast dish.

To keep dry fish nice, and prevent sliming or drying up, pack them snugly in a box, and cover up air-tight, put into a room that has no fire, (not in the cellar, unless it is a dry one,) and they will improve much by age. Always purchase slack-salted dry fish, if you want the best. English, Portsmouth, or some other salted fish are much better, and also cheaper, than the heavy, thick, pickle-salted fish, as they will swell much in soaking, while the latter will shrink. Never select a white-looking dry fish for a good one, but rather one of a yellow cast.

NEW PROCESS FOR THE PRESERVATION OF ALIMENTARY FOOD.

In a communication recently made to the French Academy, M. Sacc described his process and submitted specimens of meat and vegetables so prepared. The food to be preserved is placed in a barrel, with layers of powdered acetate of soda, in the proportion of one fourth by weight. In winter, the temperature must be raised to 20° C. After twenty-four hours, the barrels must be turned, and after forty-eight hours the process is complete, the salt having absorbed the water of the meat, which may then be headed up in the pickle, or dried in the air.

If the barrels are not full, they are to be filled up with brine of one part acetate of soda in three parts water. The pickle is evaporated down to half its bulk, crystallizing and regenerating for use one half the salt employed.

The mother liquors form an excellent extract of meat, representing three per cent of the total weight, and must be preserved and poured over the preserved meat when prepared, so as to restore the original flavor of the fresh meat, of which it is otherwise bereft by the retention of the potassic salts in the pickle.

For cooking, the preserved meat must be steeped for from twelve to twenty-four hours, according to size, in tepid water containing ten grams of sal-ammoniac per litre. This salt decomposes the acetate of soda contained in the meat, forming salt, and also ammoniacal acetate, which causes the meat to swell, and restores to it the odor and acid reactions of fresh meat.

The bones also yield an excellent and tasty soup. By adopting the precaution of simply removing the intestines, animals, etc., may thus be preserved whole. Fish, poultry,

and game have been so treated, with excellent results. Meat may be dried in a stove, losing one quarter in weight thereby, in addition to one quarter lost in pickling; but, in general, fish can not be dried at all.

Vegetables are similarly prepared, losing generally five sixths of their weight; before salting, they should be heated until they lose their rigidity. In twenty-four hours they may be pressed and dried in the air. For use they must be steeped for twelve hours in fresh water, and then boiled as if fresh. Potatoes must be steamed before salting.

Finally, all food thus prepared must be kept perfectly dry, as the salt absorbs moisture from the air.

A NEW METHOD FOR PRESERVING FOOD.

A PROCESS fo treating vegetable substances, devised by Messrs. Adamson & Simonin, consists in slicing vegetables—such as sweet potatoes, etc.—then subjecting to vapors of benzine, after which heat is applied, which removes nearly all traces of the material used. Sweet potatoes so treated may be granulated or ground to flour, and any traces of the benzine remaining may be entirely removed by soaking in water, or during the process of cooking. The small amount of hydro-carbon left in the potatoes after the first heating does good rather than harm, as it prevents the attacks of insects or worms. Meat may be deprived of its fat and desiccated in the same manner. By treating sweet potatoes and other roots as above, then granulating the slices, and pouring boiling water over the mass, the sugar contained in the roots will be taken up and the syrup so made may be evaporated in the usual way.

Mr. Adamson also suggests that the animal matters adhering to the roots of curled and other hair may be separated therefrom by exposure for a considerable time, varying with the kind of hair, to the vapors of hydro-carbons as above, or the hair may be steeped in the liquid. (The substance of four patents is included in the above.)

HYDROGEN FOR PRESERVING FOOD.

W. A. GILLESPIE proposes to preserve animal and vegetable substances by inclosing them in cases filled with water to expel the air, which, in turn, is forced out by the entrance of hydrogen gas, driven in by placing a pipe through a small aperture in the top, the cases being reversed over a trough during this process, to allow of the water passing out as the hydrogen enters. By this means the substances are entirely surrounded by hydrogen, and will therefore keep in good condition.

PRESERVING FOOD.

IT has been suggested by Adolphe Rocke, that meat may be preserved by packing it in barrels or other vessels, then withdrawing the air and replacing it by air which has been passed through hot pipes to burn out any injurious germs contained in it, and then cooled, which air may be again drawn out and replaced by other air which has not only been burnt and cooled, but has also passed through carbolic acid, after which the vessels should be securely sealed.

PRESERVING FOOD BY ACETATE OF SODA.

BY DR. SACC.—This process consists in treating meat and vegetables either with a strong aqueous solution of, or with dry acetate of soda. The substances are left in contact with that salt from twenty-four to forty-eight hours, and then dried. Meat may be placed in a strong solution of the salt alluded to; the brine from the meat is to be evaporated, and is to be added to it when being cooked, in order to restore to it a portion of the salts and extractive matters taken up by the acetate of soda, the preservative action of which seems to depend upon the withdrawal of water from the alimentary substances.

DESICCATION OF EGGS.

A METHOD suggested by A. B. Davis consists in beating together the yelks and albumen, then by the vacuum-pan or other method evaporating the mixture, without cooking, to a syrup, having the consistency of thick molasses. One and one half ounces of sugar, one third of an ounce of salt, and one tenth of an ounce of sulphite of soda per dozen eggs, are then added, and the whole thoroughly mixed. The author considers the use of the sulphite of soda to be quite important in arresting decomposition. The mixture will keep for an indefinite time in bottles, which need not be sealed. For use for culinary purposes the prepared compound is mixed with milk or water. The albumen of the egg may, in the same manner, be separately preserved if desired. (14)

PRESERVING MEAT.—Messrs. Vazques & Rosenberg preserve meat in water having acetate of lime dissolved in it until the liquid will indicate 6° in the acrometer, (salt weight.) Acetic acid is then added until the liquid will produce a sensible acid reaction on blue reaction-paper. The meat may first be put in the acetate of lime solution for two days, after which the acid may be added. Or the liquid may be injected into the meat. Meat so treated, it is said, will keep fresh a long time.

DISTINGUISHING GRAPE FROM FRUIT-WINE.

WITH ammonia, (9 parts wine to 1 part ammonia,) after a few hours, fruit-wine gives well-formed crystals adhering to the sides of the vessel—under the microscope these are seen to be regular tables—grape-wine gives a white powdery precipitate, falling to the bottom of the vessel—seen by the microscope to consist of minute star-shaped crystals. Both precipitates are soluble in dilute acetic acid, a solution of the former giving a white precipitate with ammonium oxa ate; of the latter, a similar precipitate, but smaller in amount, and in the filtrate therefrom a precipitate is formed by ammonia, which is not the case with the solution of the fruit-wine crystals. Phosphate of calcium is present in fruit-wine; phosphate of magnesium in grape-wine.

FOR PRESERVING FOOD, ANIMAL OR VEGETABLE.—J. Bruckner suggests, as an effectual method, the suspension of the substances within an air-tight apartment. He then provides a cast-iron pan, which he heats up pretty highly in a furnace, and then places sulphur upon the pan, which is set within the apartment. The combustion of the sulphur then rapidly proceeds, generating sulphurous acid gas, which permeates the substances and effectually prevents their decay. Two pounds of sulphur are used for every one hundred cubic feet of space in the apartment. The operation lasts from five to six hours. (14)

VINEGAR may be conveniently made, as suggested by A. H. Lowe, by mixing sixteen parts of pure water, one part of syrup or molasses, and one part of baker's yeast, at a temperature of about 80 Fahr., and keeping the compound in a warm atmosphere from ten to thirty days. A little old vinegar added about two days after the mixture is made will facilitate the process. (14)

CHURN THERMOMETER.—One of the latest novelties in this class of implements is that suggested by D. L. Grover, which consists in embedding a thermometer in the dasher-staff to ascertain the temperature of the cream. Such instruments are usually attached to the barrel, and are influenced more by the external atmosphere than when combined with the dasher.

PRESERVE-JARS.—To prevent fermentation and other disagreeable effects produced by the chemical actinic rays of light acting on the contents of glass preserve-jars, A. Q. Withers proposes to make such jars of colored glass that will neutralize these rays—such as yellow, orange, or red.

PHOSPHATE OF LIME AND YEAST POWDERS.

A PROCESS devised by Professor E. N. Hosford for the making of a pulverulent acid phosphate of lime consists, mainly, in mingling together a solution of monocalcic-orthophosphate and free phosphoric acid, and a solution of the phosphate of lime of burned bones in hydrochloric acid, in such proportions that the total number of atoms of lime in the mixed solution shall substantially equal the total number of atoms of phosphoric acid, and evaporating the mixture in a current of heated air to expel the volatile hydrochloric acid and water. In order to entirely remove the latter acid, a portion of the water may be returned and again driven out, after which there remains an emulsion consisting principally of minute crystals of hydrous monocalcic phosphate and water. The water may be so far removed as to leave a non-hygroscopic monocalcic phosphate, easily reducible to a dry powder, in which form it is suited to various culinary, medicinal, and other purposes; but, for its better preparation for making bread, the emulsion should be mixed with a proper proportion of starch, to give the product a certain friability, and then dried by constant stirring in currents of heated air until it is dry enough to be ground to a fine powder, in which form it is useful as the acid in yeast-powders, self-raising flour, or for other purposes.

RAISING DOUGH.—Mrs. S. V. Dodge has devised a neat arrangement for the use of housekeepers who leave their bread to rise during the night, consisting of a tin in which the dough is made, inclosed in another having on the bottom a stand on which the first one rests, and in this stand is a very small lamp, the heat of which keeps up an equable temperature all night. The inside tin is closed tight, so that the smell of the oil used does not affect the dough. The other tin may be closed too, except that sufficient space must be left open at top and bottom to supply air and draught for the lamp.

PRESERVING FOOD.—Animal matter may be preserved for food, according to T. F. Henley, by the following process: The meat, etc., reduced to small pieces, is placed in this strata between press-cloths and iron plates, and subjected to a pressure of about one hundred and forty-five pounds to the square inch, and the cakes or slabs so formed are removed from the press and treated with dry salt. The raw juices pressed from the meat are combined with meat extract or concentrated beef-tea, made from the bones and trimmings. If preferred, the press-plates may be heated, which will in most cases have a good effect.

WATER-COOLERS.

KINGSTON GODDARD proposes to manufacture the above articles by forming the exterior of wood, and inserting a lining of metal, which is secured therein by spinning, so as to fit solidly against the inside and over the edge. The cover is made in a similar manner, and both of the linings may be coated by electro-plating with some non-corrosive metal.

COMPRESSED CRANBERRIES.—These berries may be kept like dried apples, as suggested by Le Grand Kniffen, by slicing and drying them in the same manner. He proposes to do the slicing by automatic machinery, and after drying he compresses the cranberries into small bulk and puts them up in air-tight packages.

CURING HAMS.—It has been observed that the marrow left in the shank-bones of hams frequently becomes sour, and, by permeation through the bone, taints the meat. To obviate this, William N. Macqueen forces a small pipe into the bone, through which a jet of steam passes, completely cleaning out the marrow therein, and allowing the pickle to have free access to the interior.

BLEACHING PEANUTS.—The admirers of "the festive peanut" prefer those having light-colored shells; but some of the nuts, like many who cultivate them, will persist in making their appearance in shades too dark to be fashionable; and to remedy this perversity of taste, F. M. Ironmonger proposes to bleach them, (the nuts, not the cultivators,) by first washing in a solution of sal-soda in water, next immersing in a solution of chloride of lime and sulphuric acid, after which they are washed to remove the chloride, and then dried.

PRESERVING EGGS.—A. R. Davis suggests a process of preserving eggs, which consists in removing the yelks and whites from the shells and beating them up together, evaporating to the consistency of thick molasses, and adding sugar, salt, and sulphite of soda. When used, the semi-liquid mass is reduced by adding milk and water.

CUTTING UP HOGS.—An apparatus for the above purpose, devised by W. C. Marshall, consists of an inclined plane or trough in which is set a revolving cutter formed like a circular saw, but having the backs of the teeth made sharp, so that each tooth forms a complete knife. The carcase slides down the inclined plane or trough, and as it comes in contact with the revolving cutter is neatly and expeditiously divided.

PORTABLE HOUSES.

C. W. CLAYTON proposes a new method of building portable and other houses, of peculiarly tongued and grooved planks, of suitable thickness, to dispense with the ordinary framing and inside finish. These planks are pierced with holes to receive rods which tie them together, the rods having nuts at their ends to tighten the joints; and as a further protection against the weather, packing is placed in the grooves. The ceiling or second floor is formed in the same manner as the sides, and rests on a moulding formed on the upper planks of the sides of the room. In addition to the holes for the tie-rods, others are made through the planks, which serve to contain gas and water pipes, and for ventilation. (14)

LIGHTNING-ROD AND FIRE-EXTINGUISHER.

NELSON CARL proposes to attach to the roofs of houses a series of perforated pipes, which are connected to the street-mains so that the outside of the building may be protected from danger of fire by sparks from contiguous conflagrations, by simply turning on the water. These pipes are provided, at suitable distances, with pointed metallic rods, so that they may act as lightning conductors. The pipes may also enter the different apartments and be used to extinguish any fire therein. (14)

CARPETED FLOORS.—When a carpet is taken up to be cleansed, the floor beneath is generally much covered with dust. This dust is very fine and dry, and poisonous to the lungs. Before removing it, sprinkle the floor with very dilute carbolic acid, to kill any poisonous germs that may be present and to thoroughly disinfect the floor and render it sweet.

PARLOR MATCHES.—A match that will not leave a dark mark if struck on light paper has been proposed by Frederick Zaiso, who uses a mixture of phosphuret or phosphide of sulphur, chlorate of potash and nitrate of lead for the igniting material; and for the mixing or adhesive ingredients, white Russian glue, white dextrine, or dry zinc and ground flint.

NOVEL HOOKS AND EYES, suggested by Mrs. Miranda R. S. Davis, have points like pins, instead of the usual loops for attachment by sewing. These points are forced through the material of the garment, and the points are then turned backward until their extreme ends touch the cloth. By this means the hooks and eyes may be securely attached to clothing without sewing.

MATERIA MEDICA, THERAPEUTICS, HYGIENE.

THE ORIGIN OF MALARIA.

By DANIEL VAUGHAN.—While excessively moist lands in warm climates are known to be very unfavorable to health, no adequate cause for the evils is to be found in the local variation in the gaseous constituents of the air, or in any direct influence of the aqueous vapor which it contains.

Though serious evils may be justly imputed to the dust which occasionally floats around us, they must be excluded from consideration in inquiries respecting the insalubrity of marshes. In these permanent abodes of moisture dust can not be expected to rise from the ground; and its solid particles would be only removed from the air by those rains which observation proves to be instrumental in developing the activity of malaria. Alkaloids, vegetable acids, and the salts which they form, might mingle with the fresh waters of our lands; yet they can not be expected to pass into the air in a quantity sufficient to affect in a serious degree the economy of animal life. But the volatile oils emitted by living and decaying plants have the greatest tendency to charge the air with their vapors; and as the extent of this impregnation depends chiefly on heat, they appear to correspond to those malarious emanations which marshes are ready to send forth in obedience to the elevation of temperature.

The relation which I have traced between the processes of nature and of art for concentrating into a limited space the diffusible oils of plants, does not require that the water of a marsh should be subjected to a boiling heat. This will appear evident from well-known facts and principles respecting vaporization; and without insisting on the rigorous accuracy of Dalton's law, we may use it to determine approximately the amount of these volatile oils which at a certain temperature can exist as vapor in a given volume of air, or rather in a given space. This may be estimated theoretically from the boiling point of the oil and from the density of its vapor. It may be thus found that eight thousand parts of air at the temperature of 50° Fahr. would be capable of holding as vapor one part of the oil of wintergreen, two parts of the oil of meadow-weed, or sixteen parts of the oil of turpentine; but the same air could hold double the amount of these vapors at

75° Fahr. and four times as much at 100° Fahr. With regard to the ferment oils, the slow rate at which they pass over with the steam during their distillation is a sufficient indication that it requires but a very small portion of their vapors to saturate the air, even during our warmest summers. (46)

A POSITIVE SIGN OF DEATH.

IN 1870, the Academy of Sciences of Paris offered a prize of twenty thousand francs for some simple and positive sign of death, one which can be applied at any time by non-medical persons, requiring no instruments, and unmistakable in its indications.

Of course a number have been spoken of. The latest, and perhaps the best, is that suggested by Dr. Hugo Magnus, of Breslau, in one of the latest numbers of *Virchow's Archiv*. It is simple, physiological, and conclusive. Every body knows that when the circulation positively ceases the man is dead. No matter how profound the coma or trance, no matter how death-like the lethargy, some circulation *must* continue, be it ever so sluggishly. When it stops once, resuscitation is impossible.

All that one has to do, therefore, is *to tie a string firmly around the finger of the supposed corpse.* If there is the least spark of life left, that is, if the blood circulates at all, the whole finger, from the string to the tip, will gradually turn a bluish red, from the engorgement of the veins. Nothing else, no post-mortem infiltration, can be mistaken for this appearance.

The Medical and Surgical Reporter attributes a great deal of importance to this suggestion, and considers it the most practical and satisfactory of any he has seen. (15)

A NEW ANÆSTHETIC.

ROMENSKY adds a new anæsthetic to the long list of the similar chlorine substitution products of the hydrocarbons of the fatty series. This new substance is trichlorhydrin or trichloropropane, $C_3H_5Cl_3$.

In rabbits of medium size half a gram, and in larger ones one gram, causes sleep in five minutes, with diminution or entire abnegation of reflex excitability. The respiration is retarded, and the heart is quickened. The sleep lasts from ten minutes to several hours, and complete recovery ensues. In all cases there is first dilatation, then contraction of the vessels of the ear. The temperature sinks in all cases, in some as much as three degrees.

In dogs, besides the last-mentioned symptoms, vomiting

follows the administration of the drug in from 1½ to 3½ hours. In man, the vomiting, which is invariably caused, forbade the use of large hypnotic doses. Romensky, however, chose to risk the effects on himself, and swallowed two grams in a capsule. After fifteen minutes it caused sleepiness and headache and feeling of heat in the face. This condition lasted two hours without real sleep being induced. The gait was tottering and facial pain was felt. In the night, seven hours after the administration, violent vomiting came on, and catarrh of the stomach remained for two days.

Trichlorhydrin thus acts like the other anæsthetics on the nervous system, but on account of its insolubility and the irritation of the stomach which it induces, it is not well fitted for administration by the mouth.

ACTION OF OXYGEN ON THE BLOOD.

By M. Ritter.—Since the discovery of oxygen, its action on the blood and tissues has been studied by various physiologists; to whose works M. Ritter makes reference. MM. Demarquay and Leconte observed that animals could breathe pure oxygen a long time without inconvenience, and that the pulse was sometimes accelerated, and a feeling of comfort produced. Allen and Pepys inferred from experiment that the quantity of carbonic acid excreted increased with oxygenation of the air; but this has been denied. M. Ritter studied especially the influence of oxygen on urinary excretions. He submitted himself to a fixed daily diet, producing a certain quantity of urine, and he compared the urine of days on which he absorbed pure oxygen with that of other days on which he did not do so. In the former case he inhaled 25 to 30 litres of oxygen, inspiring the gas gently from a gasometer, as when one smokes. From analysis of the urine obtained under these conditions, M. Ritter found the acidity increased, the quantity of nitrogen and of urea diminished, the uric acid diminished, and the ammoniacal salts increased considerably. The products were those of advanced oxidation.

This urine obtained after inhalation of oxygen, underwent acid fermentation very quickly, and remained acid for a long time, sometimes not becoming alkaline till after two months; and he asks if therapeutical science might not take advantage of this fact in affections in which the urine has a pronounced tendency to ammoniacal fermentation, and if inhalation of oxygen might not happily modify this morbid property.

M. Ritter did not experience the feeling of comfort re-

ferred to by other physiologists; his pulse became less rapid, but fuller, the legs felt somewhat benumbed.

Comparing the urine produced in states of repose and in states of muscular activity, M. Ritter found that, after a state of complete repose, walking produces phenomena of oxidation different from those observed after inhalation of pure oxygen. The quantity of nitrogen eliminated in the urine is increased instead of diminished, and the proportion of urea to uric acid increases nearly one half. (2)

IRON IN THE BLOOD.

By Dr. Boussingault.—This memoir contains the detailed account of a series of experiments made with the view to ascertain the quantity of iron (as metal) contained in the various constituents of blood. 100 parts of fibrin contain 2·151 of mineral matter, and 0·0466 metallic iron. 100 parts of the blood-globules contain 1·325 mineral matter, and 0·350 iron. 100 parts of albumen contain 8·715 mineral matter, and 0·0863 iron. 100 parts of human blood contain 0·3 fibrin, 7·0 albumen, 12·7 globules, 1·0 mineral matter, and 79·0 water. 100 parts of cows' blood contain 0·4 fibrin, 7·4 albumen, 10·5 globules, 1·0 mineral matter, 80·7 water. The large quantity of iron met with in the blood-globules is due to the hematosine, which when separated from defibrinated blood is of a deep brown color, insoluble in pure water, but soluble in water which has been rendered slightly alkaline. 100 parts of hematosine contain 10·750 of mineral matter, wherein are 6·33 metallic iron, equal to 9·043 peroxide of iron, leaving 1·707 other mineral matter. Further research exhibited the presence of lime and phosphoric acid in the ash of hematosine, which (the ash) was found to consist, in 100 parts, of 84·121 peroxide of iron, 13·512 phosphoric acid, and 2·986 lime. 100 parts of hematosine consist of 89·25 organic matter, 9·04 peroxide of iron, 1·45 phosphoric acid, and 0·32 lime. (4)

GUARANINE.

The fruit of the *Paulina Sorbilis* is made up into rolls by the Indians of Para, in South-America, and is by them called "Guarana." Its infusion is used as a beverage, and within a few months has been introduced into medical practice, and recommended as a remedy for sick headache.

Dr. Stenhouse some years back examined guarana, and isolated the crystallizable principle, which he named guaranine, but considered it to be identical with caffeine or theine.

NITRITE OF AMYL.

THE nitrite of amyl, which is now being introduced into medicine, especially in cases of the throat and bowels, and in poisoning by hydrate of chloral, can be prepared from the inferior alcohol of commerce in the following manner. The alcohol is agitated with a concentrated solution of chloride of sodium, which diminishes its volume from sixteen to twenty per cent, and then washed with a large quantity of water. This product is distilled with a thermometer, and that portion rejected which goes over below 125° C., and which is composed of the poorest quality of alcohol. That which distills over at 125° to 140° C. is caught and rectified at 132° C. The amylic alcohol obtained is introduced into a glass retort provided with a safety-tube, and a little copper wire is put in together with a tenth part of concentrated sulphuric acid and as much nitric acid and water. The temperature is raised to 65° C., the action goes on quietly, and when the operation is over, the product condensed in the receiver is about double the volume of the nitric acid originally introduced into the retort. A fresh quantity of nitric acid, equal to the first, is again put in, and the operation repeated until the red vapor of hyponitric acid begins to appear. The product is now washed with caustic soda and then distilled over fused carbonate of potash. The portion which distills at 95° to 100° C. is sufficiently pure nitrite of amyl for medicinal purposes. (63)

NICOTIN IN TOBACCO.

DR. EMIL HEUBEL, of Kiew, a somewhat noted university in Russian Poland, gives a pretty full account of researches which he had carried on with regard to the presence of nicotin in tobacco-smoke, summing up his conclusions thus: 1 Nicotin is without doubt contained in tobacco-smoke, and its presence can be proved as well by chemical analysis as by physiological experiment. 2. During slow combustion the nicotin is to be constantly found in the smoke, a quantity of the alkaloid, varying as the tobacco is or is not rich in nicotin, passing over in the smoke. 3. This nicotin exists in tobacco-smoke, for the most part at all events, as a salt of the alkaloid. 4. The fact that nicotin, spite of its considerable volatility and easy solubility, is, during the process of smoking, by no means entirely, or even for the most part, dissipated or dissolved, appears to have its solution in the circumstance that in tobacco-smoke, as well as in tobacco-leaves, the nicotin exists, not as a free alkaloid, but as a stable salt of nicotin. 5. In the working of tobacco-

smoke both upon the human and brute organisms an essential share in the effect is taken by the nicotin ingredient of the smoke. In the course of his preliminary remarks, Dr. Heubel records a striking experiment thus "That a relatively large quantity of nicotin passes over in tobacco-smoke seems to be supported by the following observation which I once made—that the smoke, only partially collected and condensed, derived from the combustion of but a single cigar, and from which, after condensation, only from six to eight drops of distillate were derived, was amply sufficient to produce in a large frog the most violent nicotin convulsions, general paralysis, and death."

THE FEVER-TREE.

DR. PEDRO L. N. CHERNOVIS, of Bahia, in a late number of the *Gazeta Medica da Bahia*, gives a very interesting account of the history, uses, propagation, medical and miscellaneous properties of the *Eucalyptus globulus*, an immense tree introduced into various provinces of Brazil from Australia, and called, as in Spain, *arvore da febre*, from its "marvelous results in the treatment of intermittent fevers." The tree is colossal, sometimes attaining a height of 300 feet and a diameter of 30 feet. All parts are aromatic; less so in the trunk and bark, more so in the small roots, flowers, and leaves. It is a comparatively new medicine of much promise, and is given internally for intermittent fever, in doses of from one to four drachms of the powdered leaves—twice during the intermissions—or in infusion, (two drachms in four ounces of boiling water,) morning and evening. Aqueous and alcoholic extracts, in doses of from two to eight grains, are also used for the same disease. One or two drops of its essential oil, on sugar, in pill or capsule, are advised in bronchial and pulmonary affections, laryngitis, and catarrhal aphonia. (66)

POISONOUS COLORS.

COAL-TAR colors are frequently the cause of distressing symptoms in the human economy. Aniline itself is a poison, and all colors that contain it in an unchanged state are consequently more or less toxic in their action. The agents employed in the preparation of aniline colors are in many instances very deleterious. Among these are the compounds of arsenic, zinc, tin, antimony, lead, together with hydrochloric and picric acids.

The common or inferior colors prepared from residues are especially dangerous, and are, on account of their cheapness, employed in coloring paper-hangings, wooden

toys, matches, india-rubber articles, and confectionery. In the dyeing of woolen and other tissues, the common aniline colors are also extensively used, and sewing-girls frequently suffer severely from the presence of arsenic and picric acid in their materials: their fingers become inflamed and dotted with small pimples upon a red ground; the same eruptions after awhile appear upon the face, the lips are of a dark-violet color, and there is trembling of the hands and feet, accelerated pulse, and difficult respiration.

PHYSIOLOGICAL ACTION OF KINIC ACID.

BY M. RABUTEAU.—Kinic acid agrees in its action with citric and tartaric acids, and has no active properties peculiar to itself. Its alkaline salts have no taste, and, like those of other organic acids, are converted into carbonates in the body. They cause constipation when injected into the blood, and would probably be purgative if introduced in sufficient quantity into the alimentary canal. Ferric chloride is readily reduced by organic substances. To this reduction is due the blue stain which is produced on the hands after using ferric salts or potassium ferrocyanide. The author considers that ferric salts are reduced to ferrous in the stomach, and are absorbed as such, and that when ferric chloride has been injected into a varicose vein to coagulate the blood, the coagulum which it at first produces afterward disappears, because the ferric salt is converted into a ferrous salt which hinders the coagulation of the blood instead of inducing it.

ATOMIZING DISINFECTANTS.

A NEW apparatus for the above purpose, invented by Messrs. E. S. De Luce and H. M. Wells, consists of a steam-chest surmounted by a chamber to receive the disinfectant, through which the steam-pipe to supply the chest passes. From the chamber project two or more jet-pipes, and from the chest lead corresponding steam-pipes which connect with and surround the jet-pipes. The heat radiated from the steam supply pipe and chest rapidly heats and volatilizes the disinfectant, and as it passes out of the jet-pipes it is carried away in the form of a fine spray or vapor by the escaping steam. If steam should be objectionable, hot air may be forced into the steam-chest in lieu thereof.

MEDICAL EXTRACTS.—A process for making extracts, suggested by L. De Puy, consists in macerating the drugs or herbs in a closed vessel under a pressure of from eight to ten atmospheres without heat.

REMEDY FOR DYSPEPSIA.

MR. THOMAS LUTTON, the well-known photographer, in speaking of the use of sulphur and sulphites in his art, mentions the fact that he has found the use of sulphine, prepared by W. Parke, of Wolverhampton, Eng., to be a perfect remedy in his individual case for chronic dyspepsia. A table-spoonful of sulphine in a glass of ale at dinner is what restored him. It imparts no taste to the ale. (25)

EMBALMING COMPOSITION.

BY DR. BUFALINE.—For the purpose especially of preserving cadavers for anatomical use, the author recommends the following mixture:—Camphor and pure carbolic acid, each, 70 grms.; paraffin oil, 200 grms. This fluid is either applied by injection into the blood-vessels, or the parts of the cadaver to be kept are soaked in it.

REMOVAL OF CARBONIC OXIDE FROM THE BLOOD.

N. ZUNTZ placed blood saturated with carbonic oxide in the receiver of Pflüger's gas-pump, and found, on warming it to 37°–42°, that there was an active escape of gas, which apparently ceased at the end of half an hour. When the pumping was continued at various intervals, however, fresh quantities of gas were freed. More was again obtained by heating the receiver to 60°. 17.7 per cent in all of the blood-volume.

The chief point to be observed is, that the gas can not be pumped out all at once, but is evolved at intervals only. Schöffer found that this was also true of carbonic acid, and he attributed it to the progressive development of an acid which set free the gas. Zuntz shows that this supposition is untenable; for he finds by experiment that the same is true of solutions of sodium bicarbonate, which also parts with its carbonic acid in a fitful manner, an effect which can not in this case be attributed to the development of any acid. These experiments sufficiently account for other investigators not having been able to extract carbonic oxide from the blood, as the process was supposed to be complete when no more gas was evolved after the first pumping. Zuntz also points out some errors in the methods adopted by Pokrowsky. These results must modify received ideas regarding carbonic oxide poisoning. There is no longer need to suppose that carbonic oxide can only be removed from the blood by oxidation into carbonic acid. As long as the heart still beats there is hope, by energetic artificial respiration, of again restoring the blood to its normal condition. (32) (34)

CUTANEOUS ABSORPTION.

"ABSORPTION in the bath," says Reveil, "only takes place in rare and exceptional circumstances; it is facilitated by washing the skin, continued rubbing, and by certain irritant and solvent substances."

In a series of experiments by M. Bernard, at Vincennes, the bath apparatus consisted of a furnace, a boiler, a chamber in which the steam coming from the boiler was charged with the substance to be applied, and a wooden cage, in which the patient was seated while enveloped in the vapor.

I used iodide of potassium in my experiments.

The skin of the subject experimented on was intact, without wound or scratch. The urine was examined before the bath was taken, and the absence of iodine ascertained. By a respiratory tube, the patient breathed the external air through his mouth, the nostrils being pinched.

The subject was then placed in the cage, and subjected for thirty minutes to vapor from the mixing chamber, into which there had been put 20 grms. of iodide of potassium. The temperature in the cage was gradually raised to 45°; the skin of the subject became wet. He was then wrapped in a woolen covering and put in bed, when profuse perspiration took place. The urine analyzed two hours after the bath gave a rose color; some taken three hours after gave a much more lively color; thus affording clear proof of the absorption of iodide of potassium through the skin, the only way it could have entered the system.

HOW TO TREAT MELANCHOLIA.

IN the pages of a German contemporary, a writer, Dr. Mendel, maintains that it is a mistake to treat melancholy by means of concerts, society, theatres, and the like. It is caused by hyperæsthesia of the brain, and requires rest from all kinds of excitement. The patient should reside in some very quiet and retired country place. This often produces a rapid cure, and sleep returns to the patient who has long suffered from insomnia. Warm baths are also to be recommended. A great proportion of such cases get well spontaneously, and do not require any medicine internally. The use of morphia subcutaneously injected, however, is sometimes indicated. Dr. Mendel speaks very highly also of chloral when a temporary sedative is required, since it is much quicker in its operation than morphia injection. The author has found in many cases of chronic melancholy thickening of the pia mater, com-

bined with hyperæmia of the brain. In many cases where morphia injection is useful, symptoms of pressure have been remarked by the author, such as slight paresis of the facial nerve, deviation of the tongue, of the uvula, and difference in the size of the pupils. (15)

COMPOSITION OF THE BONES.

By H. Weiske-Proskau.—Papillon had found that considerable quantities of earthy phosphates—strontium phosphates among others—mixed with the food, were deposited in the bones. The author, with the assistance of E. Wildt, repeated these experiments on young and old rabbits, but could not find the slightest trace of strontia, or any noteworthy increase of the magnesia, lime, or phosphoric acid in the bones when earthy phosphates were mixed with the food. The age of the animal has an influence on the composition of the bones, those of old rabbits containing more salts than those of young ones. The percentage composition of the bone-ash is much alike in both, but the proportion of magnesia seems to be somewhat higher, and of lime somewhat lower, in young animals. The percentage amount of phosphoric acid is almost the same in all bones, and is on an average 42.17 per cent. (33)

ELECTRO-THERAPEUTICS.

Dr. Geo. M. Beard, in a paper in the *New-York Medical Journal*, gives an account of a novel method of electrization, which he terms "central galvanization." It consists briefly in applying the negative pole to the epigastrium (the patient holding it by an insulated electrode) while the positive is applied over the head, around the sympathetic, and down the whole length of the spine, in such a way as to bring the brain, the pneumo-gastric, the spinal cord, and all the prominent plexuses of the sympathetic, indeed, the whole central nervous system, under the influence of the current. This differs from general faradization, in that it chiefly affects the central nervous system, while in the latter a large part of the muscular surface of the body is acted upon. Central galvanization is especially valuable in many forms of aneuric diseases, such as hysteria, insanity, neuralgia, and the like, where the muscular strength and general nutrition may be comparatively undisturbed. (15)

Capsicum Plaster.—As a rheumatic remedy, Messrs. J. & I. Coddington propose to add extract of African capsicum to the common *emplastrum resinæ*, either by sprinkling over the plaster or mixing with the *emplastrum* before spreading.

COTTON-ROOT.

DR. E. S. WAYNE.—The root of the cotton-plant *(Gossypium herbaceum)* is used medicinally in some portions of the United States as an emmenagogue, parturient, and abortive, and is said to promote uterine contractions with as much efficiency and more safety than ergot, *(Secale cornutum.)* The author ascertained that it contained no propylamine or such alkaloids as ergotina and ecbolia, but a red-colored resinous body was found, which is insoluble in alcohol, chloroform, ether, and liquid ammonin, but is soluble in solutions of caustic potassa and soda. This substance, which appears to be due to the rapid oxidation of a body met with in all parts of the plant, is termed by the author gossypic acid. The author incidentally mentions that cotton-seed cake (the mass left after pressing the oil out) contains more or less of this resin, and that if cows are fed upon it abortion is produced. (17)

IRON IN THE BLOOD AND IN FOOD.

NUMEROUS analyses are given by M. Boussingault, showing the wide distribution of iron in articles of food and in the animal body. The quantity of iron taken daily by a man in his food and drink is estimated at from .0591 to .109 gram, (from $\frac{4}{5}$ to $1\frac{7}{2}$ grains.) Observations are offered on the existence of iron in the coloring matter of blood and of plants respectively. It is asserted that etiolated plants and the bodies of animals having white blood contain only as much iron as green plants and animals nourished with red blood.

GLYCOGENIC FUNCTION OF THE MUSCLES.

THE theory of diabetes which regards the sugar simply as that which has passed into the urine directly from the food is proved insufficient to account for all the phenomena. Dock suggests that the explanation is, in all probability, to be sought for in the muscles, which may have the power of storing up glycogen or sugar and retaining it more tenaciously than the liver, capable, under certain conditions, of again being given up and appearing as sugar in the urine.

EFFECT OF SEWER-GAS.

INVESTIGATION into the probable cause of the sickness which has recently caused the closing of the Rhode Island Conference Seminary, at Greenwich, R. I., has resulted in the discovery of a leak in the sewer, in the rear of a boarding-house, caused by rats, by which a portion of the sink-drainage was deposited under the rear of the house. (15)

BLOOD IN URINE.

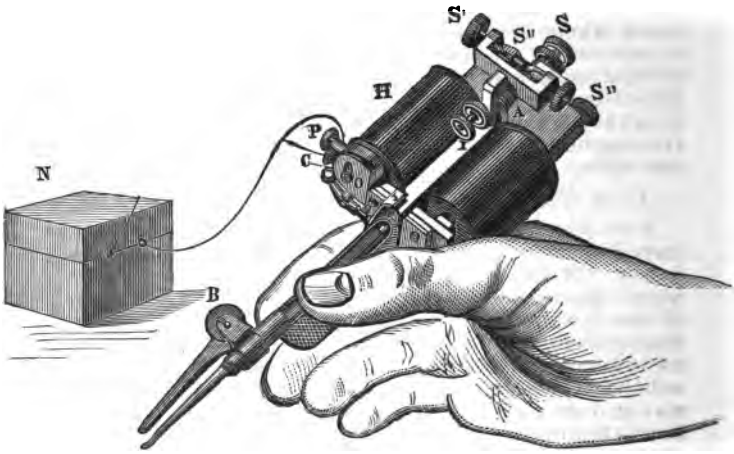
To discover traces of blood in urine, etc., add ammonium or potassium hydrate, then a solution of tannin, and, lastly, acetic acid until the solution is slightly acid. If blood be present, a dark-colored precipitate will immediately form, which, after treatment with ammonium chloride and glacial acetic acid, will yield splendid crystals of hæmatin.

GOATS FED ON VEGETABLE AND ANIMAL DIET.

Two kids of the same age were taken, and one was quickly weaned and fed on a vegetable diet, while the other was fed exclusively on milk. When both were seven months old, their urine was collected and compared. That of the first kid, fed on vegetable diet, presented the usual characters of the urine of herbivora, being turbid, alkaline, and effervescing with acids; while that of the second, which was fed on milk, was perfectly clear and strongly acid, like the urine of carnivora. The urine of the first was very concentrated, (sp. gr. 1058,) and 100 cub. cent. contained on an average 11.08 grams of solids, 5.19 of ash, and 1.11 of nitrogen. The addition of hydrochloric acid caused a deeply-colored deposit of hippuric acid to form after some time. The urine of the second animal had a sp. gr. of 1.011, and 100 c.c. contained, on an average, 1.75 grams of solids, 0.57 of ash, and 0.33 of nitrogen. The urine of the second animal contained a large quantity of phosphates, while the first contained only traces of them, but large quantities of carbonates and sulphates.

FLUID MEAT.—Stephen Darby makes a "fluid meat" by digesting one pound of lean meat in two gallons of water containing one and a half per cent of hydrochloric acid, at a temperature of 100° Fahr. He next neutralizes the acid with soda, and then adds one ounce of finely-minced pancreas, or sweet-bread, and again digests until the bitterness is removed. The liquid is then filtered and evaporated to a proper consistency. The addition of the pancreas overcomes the bitter taste usually found in meat digested in pepsin or hydrochloric acid.

MEDICATED CANDY.—To induce our little friends to take medicine, J. C. Wells mixes the desired drugs with an equal portion of candy, and the mass is then covered with pure candy and drawn into sticks, so that the medicinal substance is completely covered up and is not eaten until the tongue has become thoroughly saturated with the sweet covering.



THE ELECTRIC DENTAL MALLET.

(ONE HALF SIZE.)

IT is composed of a horse-shoe magnet (H) with a frame attached which supports the mallet or armature, and at the opposite end the cylinder or tube, open on one side for thumb to rest on plugger, which passes through it; (J) the spring which secures the plugger from passing too far either way in tube; (O) the black rubber key which, when pressed up by the thumb, while holding the instrument in hand, forces the lever up and breaks the circuit permanently; (C) the platina points where the current is broken at the binding-post, (P,) and on the lever pressing thereon, which is controlled by the slide, upon which rests the right index-finger. This is for the temporary breaking of current, (P.) Binding-posts for flexible wires from battery, (N;) (S') screws; (A) the conical spring which sustains the mallet; (B) the bobbin or automatic feeder. An automatic break on the instrument renders it self-operating.

In the use of this electric mallet the number of blows range from 500 to 1000 per minute—more than are requisite to produce the desired results. The regularity of the blow enables the operator to pack against frail walls of the tooth without danger, and also to condense the periphery of fillings, or those portions contiguous to walls, as solid as other parts. The action of the instrument is not unpleasant; when the blows are impressed with the great rapidity and regularity these are, the mind fails to

detect individual strokes. The electrical mallet in dentistry alone is a blessing; it saves labor, strength, patience, pain, time, and in the end brings the work of the dentist as nearly as possible to nature and perfection. Dentists of the highest rank in their profession speak of it in the highest terms. In the filling of teeth by the electro-magnetic mallet, 30,000 blows have been dealt upon one filling, without fatigue to either operator or patient.

CONTAGIOUS DISEASES SPREAD BY FLIES.

A CURIOUS and perhaps important discovery is stated to have been made recently by M. Kletzinsky, a Viennese professor. Noticing that persons sick with the small-pox were often visited by flies, he placed near an open window of the hospital a saucer filled with glycerine. Soon the flies gathered and were caught like birds with glue. In their endeavors to free themselves, all the foreign matter which had adhered to them was left in the glycerine, which was at once submitted to observation with the microscope. It was found that the glycerine, which was chemically pure when offered to the flies, was full of strange cells very similar to those seen on persons attacked by small-pox, but never on flies—a discovery which proves conclusively that these insects are not only filthy, but can be a very dangerous means of spreading contagious diseases.

THE STORING UP OF FAT.

BY F. HOFMANN.—The author seeks to determine by exact experiments in what way fat becomes deposited in the body, whether directly derived from the fatty elements of the food; or whether, as Toldt and Subbotin hold, it is derived from the splitting up of albuminoïds; or whether, according to the views of Radziejewski, all fats must be first saponified and again undergo synthesis into neutral fat in the organism. To this latter conclusion Radziejewski was led by his experiments on the feeding of animals with fats which do not normally exist in the body. Hofmann criticises the experiments of Radziejewski, and thinks his conclusions are far wider than his premises, since these premises only prove that foreign fats are not stored up. The same is shown by Subbotin's experiments with spermaceti.

Hofmann's method consisted in starving dogs till all the body-fat was used up, and then feeding them with large quantities of fat, mixed with as small a proportion as possible of lean meat. After a few days the animals were killed, and the whole quantity of fat in the body determined. The fat found was considered first, as that derived from albuminoïds. If the quantity found is not

greater than might possibly be derived from albuminoïds, it is considered that all the fat of the food has been burnt, and none deposited. If, on the other hand, a larger proportion of fat is found than can be accounted for in this way, it can only have come from the food. This would not, however, decide the question whether the fat was stored up in the cells, for it might exist in the blood. If, however, not more than usual is found in the blood, and an amount corresponding to the quantity absorbed is found in the whole body, then it is considered as fat really deposited in the tissues of the body.

These points are all carefully attended to in the course of the experiments.

The first difficulty is in determining when the whole of the fat of the body has been used up by the process of starvation. Considerable differences in time are observed, according as the animal has or has not a large store of albuminoïds, as well as fat, in its system. In general it is found that the fat of the body is almost entirely absorbed when the excretion of urea suddenly becomes greatly increased after a long period of starvation. This indicates that the wants of the organism require the combustion of a large amount of nitrogenous constituents to make up for the want of the fat which has now disappeared.

A dog so starved was found capable of assimilating considerable quantities of fat, when mixed with a small proportion of flesh. At the end of a few days, however, dyspeptic symptoms appeared, and almost pure fat was passed per anum. This was attributed to the fatty condition of the liver which was induced. The animal in five days increased in weight more than 21 per cent of its weight on the last day of starvation. This increase was shown not to be due to water alone, nor to the small amount of lean meat of the food. Analysis of the blood likewise proved that this did not contain more than the usual proportion of fat.

The whole amount of fat in the body was determined in a novel way, consisting in the thorough mincing of the whole animal, and reduction of all its tissues to a uniform mass. Fractional analysis of this mass gave uniform results, and allowed of easy estimation of the whole fat in the body.

The tables show that in five days a dog had absorbed 1854.0 grams fat. If 130.7 grams be taken as the amount derived from albuminoïds, a total of 1984.7 grams represents what was used by the organism.

Analysis found in the body 1352.7 grams, giving 632.0, which are considered to have undergone combustion.

These figures show that a very large amount of fat may be absorbed from the food, and be deposited in the tissues. The deposit takes place principally in the liver and mesentery.

Hofmann questions whether it will be possible by the above method to determine whether fatty acids may undergo synthesis into fat, as it is impossible to give large quantities of soaps to animals without inducing serious derangement of the alimentary canal.

That fats are deposited in the organism, and not all burnt off, is also shown by the experiments of Pettenkofer and Voit, which are adduced. These prove that the amount of carbon given off by an animal receiving a large proportion of fat in its food is far below what would be required to cover the amount of fat consumed. (32)

THE NERVES OF TASTE.

M. LUSSANA, on the nerves of taste, shows, from pathological cases, that the sense of taste in the forepart of the tounge is not derived, as has always been supposed, from the fifth nerve, since the branches of this nerve may be entirely paralysed, and yet the taste be perfectly preserved. He likewise refers to cases in which the taste was entirely lost, while the sensitiveness to tactile impressions was undiminished in all the parts supplied by the fifth nerve; on the other hand, the sense of taste in the forepart of the tongue is lost after section of the facial nerve near its origin. M. Lussana therefore considers that the gustatory nerves of this part are due to the fibres from the facial contained in the *chorda tympani* which joins the gustatory branch of the fifth nerve, and not to the fifth itself.

REMEDY FOR DANDRUFF.

BY DR. J. L. DAVIS.—The belief that dandruff arises from a disease of the skin, although physicians do not seem to agree on this point, and the knowledge that the use of sulphur is frequently attended with very happy results in such diseases, induced me to try it in my own case. A preparation of one ounce flowers of sulphur and one quart of water was made. The clear liquid was poured off, after the mixture had been repeatedly agitated during intervals of a few hours, and the head was saturated with this every morning.

In a few weeks every trace of dandruff had disappeared, the hair became soft and glossy, and now, after a discontinuance of the treatment for eighteen months, there is no indication of the return of the disease. I do not pretend to explain the *modus operandi* of the treatment, for it is well known that sublimed sulphur is almost or wholly insolu-

ble, and the liquid used was destitute of taste, color or smell. The effects speak for itself. Other persons to whom it has been recommended have had the same results, and I communicate the result of my experiments in the belief that it may be valuable and acceptable to many who have suffered in the same manner as myself.

MICROCOCCI IN MEASLES AND SCARLET FEVER.

DR. HALLIER, well known by his researches upon the fungi as supposed agents or concomitants of disease, states in a recent paper that measles and scarlet fever are both occasioned by the presence of certain fungi in the blood, which can be seen by the microscope in the form of minute cell-like spores, called micrococcus. In the course of treatment of persons affected with the above diseases, care was taken to collect the perspiration obtained from the patients under these circumstances, and which, on being submitted to Dr. Hallier for examination, was found to contain the micrococcus in abundance.

PHYSIOLOGY OF HUMAN BILE.

BY V. WITTICH.—Von Wittich criticises a statement made by Ranke in his *Physiologie*, viz.: "The bile of the pig, as Nasse has shown, possesses the power of converting starch into sugar. Neither the bile of other animals nor of man possesses this property." He points out that he and Jacobson had already shown that this was not the case. The difficulty in regard to human bile is the possibility of obtaining it quite fresh. Von Wittich has been fortunate enough to obtain bile, perfectly fresh, and in sufficient quantity for experimentation, from a patient laboring under a biliary fistula opening externally.

Careful calculation of the amount poured out gave an average of 22.2 c.c. per hour, and 532.8 c.c. in the twenty-four hours.

Boiled starch mixed with from twenty to thirty drops of bile, and left for an hour at the ordinary temperature, gave a distinct sugar reaction with copper sulphate. The bile, mixed with absolute alcohol as long as it exhibited turbidity, left on filtration a residue which, on being treated with glycerin, yielded an extract which, after twenty-four hours, possessed an energetic diastatic action. Still more active was the alcoholic precipitate of the extract dissolved in water. Human bile therefore appears undoubtedly to contain an active diastatic ferment. (32) (34)

LOCAL ANÆSTHETIC.—For a compound to be used as a local anæsthetic, M. H. Campbell proposes to use a mixture of one gallon of tincture of pyrethum, three quarters of an oz. of veratria, and a half oz. of acetate of morphine.

NATURAL HISTORY AND ZOOLOGY.

A NEW RHINOCEROS.

THE acquisition of a living rhinoceros belonging to a species hitherto unknown to science, is certainly a remarkable event, and one that may well give comfort to those who may have supposed that the field of zoölogical discovery is worked out. If so large a beast has hitherto escaped the observation of naturalists, how many smaller animals must there still remain for the zoölogical explorer. But the truth is, that we know less about some of these very bulky animals than those of more moderate dimensions, as their very size renders the collection and preparation of specimens of them more difficult. The importation of such monsters in a living state is a still more serious undertaking, and it is only within the last few years that the Zoölogical Gardens of Europe have become wealthy and enterprising enough to find funds for such expensive luxuries.

The animal of which we are now speaking was originally captured near Chittagong, at the northernmost extremity of the Bay of Bengal, in January, 1868, by some officers engaged in the supply of elephants for the Indian army. Some natives came into the station, and reported that a rhinoceros had fallen into a quicksand, at a place about sixteen hours' journey to the south, and had been unable to extricate itself. They had pulled it out by ropes attached to its neck, and had bound it between two trees, but were fearful of its breaking loose. Captain Hood and Mr. H. W. Wickes accordingly started with eight elephants, and brought the rhinoceros into Chittagong, where she was kept in a stockaded inclosure, "having a good bath excavated in the ground, and a comfortable shed attached to it." Here "Begum," as she was named, remained for nearly four years. Various negotiations were entered into between the Zoölogical Society of London and the capturers, for her removal to England, but these never came to any definite result. Besides the difficulty of arranging terms at such a distance apart, there seemed to be some question about the true ownership of the animal, which created additional embarrassment in the transaction. At length, in the autumn of 1871, Mr. William Jamrach, the well-known dealer in living animals, being personally in Calcutta, was

NEW HAIRY-EARED RHINOCEROS. [RHINOCEROS LASIOTIS.]

able to conduct the negotiations to a successful result, and on his return to England, in February, 1872, brought the animal with him. Upon her arrival, "Begum" was immediately purchased by the Zoölogical Society, to whom, it was understood, the first offer was to be made for the sum of $6250.

The Chittagong animal is proposed to be called the hairy-eared rhinoceros, (*Rhinoceros lasiotis,*) from its peculiar ear-fringe of long hairs. How far the Sumatran rhinoceros extends north along the Malayan peninsula is not yet ascertained, because, although two-horned rhinoceroses are known to occur in several intermediate localities, it is uncertain to which of the species they belong. The range of *R. lasiotis* is likewise quite a matter of uncertainty at present, the animal being utterly unknown except from the individual in the Zoölogical Society's Gardens. But it is probable that it extends into Assam, where there are reports of the occurrence of a two-horned species of rhinoceros.

By the addition of the animal to their menagerie the Zoölogical Society have now been able to exhibit side by side specimens of four (out of the six certainly known) living species of rhinoceros—a wonderful advance, when we consider that a very few years ago the Indian *Rhinoceros unicornis* was alone known in Europe in a living state. The two species remaining to be obtained are the Javan rhinoceros, (*Rhinoceros sondaicus,*) a smaller representative of the one-horned Indian, and the white rhinoceros of Africa, (*Rhinoceros simus.*) (47)

INTELLIGENCE IN MONKEYS.

I HAVE, says Prof. Cope, two species of *Cebus* in my study, *C. capucinus*, and a half-grown *C. apella*. The former displays the usual traits of monkey ingenuity. He is an admirable catcher, seldom missing any thing, from a large brush to a grain, using two hands or one. His cage-door is fastened by two hooks, and these are kept in their places by nails driven in behind them. He generally finds means, sooner or later, to draw out the nails, unhook the hooks, and get free. He then occupies himself in breaking up various objects and examining their interior appearances, no doubt in search of food. To prevent his escape, I fastened him by a leather strap to the slats of the cage; but he soon untied the knot, and then relieved himself of the strap by cutting and drawing out the threads which held the flap for the buckle. He then used the strap in a novel way. He was accustomed to catch his food (bread, potatoes, fruit, etc.), with his hands when thrown to him;

sometimes the pieces fell short three or four feet. One day he seized his strap and began to throw it at the food, retaining his hold of one end. He took pretty correct aim, and finally drew the pieces to within reach of his hand. This performance he constantly repeats, hooking and pulling the articles to him in turns and loops of the strap. Sometimes he loses his hold of the strap. If the poker is handed him, he uses that with some skill for the recovery of the strap. When this is drawn in, he secures his food as before. Here is an act of intelligence which must have been originated by some monkey, since no lower or ancestral type of mammals possess the hands necessary for its accomplishment. Whether originated by Jack, or by some ancestor of the forest for the same purpose, can not be readily ascertained.

After a punishment, the animal would only exert himself in this way when not watched; as soon as an eye was directed to him, he would cease. In this he displayed distrust. He also usually exhibited the disposition to accumulate, to be quite superior to hunger; thus he always appropriated all the food within reach before beginning to eat. When different pieces were offered to him, he transferred the first to his hind feet to make room for more; and then filled his mouth and hands, and concealed portions behind him. With a large piece in his hands, he would pick the hand of his master clean before using his own, which he was sure of. (30)

AMERICAN ASPHALTUM.

DR. J. S. NEWBERRY.—The opinion of the author is that all asphaltes are more or less perfectly-solidified residual products of the spontaneous evaporation of petroleum. The chief asphalte deposits of North-America (including Canada, New-Brunswick, and California) are then briefly described. It appears that asphalte is found in large quantities and in different stages of formation, its origin from petroleum being very plainly exhibited in South California, where the accumulations of asphalte on the coast of Santa Barbara, San Luis, Obispo, and other localities, have attracted the notice of all travelers visiting that region. When the asphalte drips from the cliffs, and forms a scum on the ocean off the coast, it is evaporated and oxidized, and then thrown upon the beach by the waves. In the neighborhood of Chicago, Ill., the limestone formation is in some places saturated with a thick petroleum, which, on exposure to air, is converted into asphalte. The author thinks that, notwithstanding the large quantity of asphalte met with in this country, for

practical purposes it will be cheaper and more convenient to bring the Trinidad asphalte to America, because the transport and working of the asphalte found here will be too expensive, and the quantity found in the island of Trinidad is inexhaustible.

NATIVE SULPHURIC ACID IN TEXAS.

BY PROF. J. W. MALLET.—Not far from the Gulf of Mexico, and within twenty-five or thirty miles to the westward of the Neches river, there occur at several localities—in some instances in the woods, in others in the midst of open prairie—small drainage-wells and shallow pools of water strongly sour to the taste. This sourness is due to the presence of free sulphuric acid, which is accompanied by various salts, especially aluminium and iron sulphates. At most of these points gases are continually escaping, (hydrogen sulphide, marsh gas, and carbonic anhydride,) the bubbles burning readily on the application of a light.

At the bottom of the water in some instances, as at one point where, by means of an artificial bank, a pond has been formed of some 250 feet in diameter, known locally as the "sour lake," an earthy crust with intermingled free sulphur is observable. A thick, tarry variety of petroleum is found oozing from the surrounding soil, occasionally to such an extent that sods taken up with a spade are set on fire and used to give light in the open air at night.

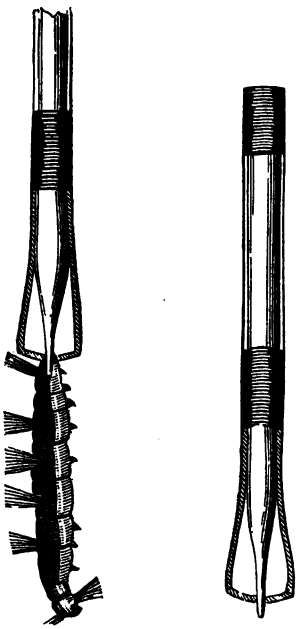
At a point in Louisiana some fifty or sixty miles further east, where, however, the acid water does not occur, though combustible gas and petroleum are met with on the surface, a most remarkable bed of native sulphur, 100 *feet in thickness*, has been reached at the depth of 450 feet by boring, and a shaft is being at present sunk for its exploitation. This large mass of native sulphur is more or less mingled with calcium carbonate, and underlaid by gypsum. The circumstances connected with the occurrence together in this region of combustible gases, petroleum, sulphur, sulphuric acid, and gypsum are of great interest in relation to the mineral history of native sulphur.

The sulphuric acid water, which seems to be probably altogether of superficial origin, is worthy of notice from the unusual strength occasionally attained. The water varies very much at the different localities and at different times. In one instance, a specimen examined by Dr. Mallet contained no less than 5·290 grms. of free sulphuric

acid (H_2SO_4) to the litre, or 370 grs. to the imperial gallon, this exceeding any amount hitherto reported from other localities, unless the acid spring of the Paramor de Ruiz, in New-Granada, be an exception, examined by Lewy, who does not state precisely how much of the very large quantity of sulphuric acid found is uncombined with bases. The water of the Rio Vinagre, flowing from the volcano of Purace in the Andes of Popayan, as described by Humboldt and Boussingault, contains only 1·11 of free sulphuric acid (SO_3?) in 1000 parts of the water, with 0·91 of hydrochloric acid.

It is said, on the authority of Confederate officers serving west of the Mississippi, that during the blockade of Southern ports the galvanic batteries of telegraph offices in Texas and Western Louisiana were worked with this native sulphuric acid.

PRESERVING LARVÆ.



LARVÆ BLOW-PIPE.

A VERY simple but convenient method of preserving larvæ is described by Mr. Auld, in Hardwicke's Science Gossip, as follows: A blow-pipe is first prepared by melting the end of a small glass tube, drawing it out and breaking off the point. Next attach two pieces of watch-spring, as shown in the figure, so as to clasp and hold the larvæ wher the tube is inserted. Having killed the larvæ by placing it in the cyanide bottle, remove the internal organs by forcing them, with the thumb and finger, through the anal orifice; then attach to the blow-pipe as indicated, and inflate, holding the larva while inflated, and until dried, within a previously well-heated oven. The latter may consist of a glass bottle, heated by a spirit-lamp, arranged as shown. Care should be taken not

to inflate too much, otherwise an unnatural appearance will be imparted. Two or three minutes will suffice for the drying, when the larvæ may be removed. Most larvæ will retain their natural colors when thus prepared; but some specimens will change and require artificial coloring, which may in some cases be done by puffing the color into it. Privet hank-moth, for example, is puffed with emerald green. The use of gloves is advised in handling the larvæ, otherwise the skin will be irritated as if stung with nettles.

CURIOUS HABIT OF A SNAKE.

I HAD for some time, says Prof. Cope, a specimen of *Cyclophis Œstivus*, received from Fort Macon, N. C., through the kindness of Dr. Yarrow, living in a Wardian case. The slender form of this snake, and its beautiful green and yellow colors, have led to the opinion that it is of arboreal or bush-loving habits. It never exhibited such in confinement, however, and instead of climbing over the Caladia, ferns, etc., lived mostly under-ground. It had a curious habit of projecting its head and two or three inches of its body above the ground, and holding them for hours rigidly in a fixed attitude. In this position it resembled very closely a sprout or shoot of some green succulent plant, and might readily be mistaken for such by small animals.

MARINE AQUARIA.

AN aquarium of peculiar interest and importance is now rapidly approaching completion at Naples, in the spot, perhaps, most favored in the world for obtaining rare and interesting marine animals. Another public aquarium is about to be erected at Manchester, one at

Jersey, and one at Yarmouth. Moreover, the Brighton Aquarium has been opened, and has excited a great deal of interest. A splendid marine aquarium will form one of the features of interest of the Vienna Exhibition next year, and will remain subsequently as a permanent attraction. The aquarium in course of construction at Naples has more of international interest than, perhaps, any other. The expense of its installation and maintenance will be almost entirely borne by Dr. Anton Dorhn, a German naturalist of fortune. Laboratories for biological study will be connected with it, and a well-stocked library. The principal learned societies and scientific publishers throughout Europe have liberally supplemented by gifts any deficiencies in Dr. Dorhn's collection of books. It is as large as the Crystal Palace Aquarium, and will be provided with fac-simile machinery. The aquarium at Vienna will be of large proportions; it will cost £35,000, and will be opened next May; it is being constructed by Mr. C. H. Driver, the architect, and under the direction of Mr. Lloyd, the superintendent, of the Crystal Palace Aquarium. It is most essential that the machinery for that establishment should be very perfect, for this is the most inland place hitherto occupied by an aquarium of such dimensions, and its construction is a bold undertaking. The nearest seaport, Trieste, is twenty hours distant by fast train. It will contain nearly 200,000 gallons of sea-water, weighing in round numbers 2,000,000 lbs., and the cost of transport of the water will be £1000. Externally the architecture will be decorative; internally it will be plain. The general health of the population of the tanks at Sydenham has been singularly good, and this is well shown by the large number of births of some animals, and the growth of others in size. One species of fish, belonging to the great cod family, has on several occasions brought forth innumerable quantities of living young. Not one of these, however, has ever been reared; they were either eaten by their unnatural parents or by other creatures as soon as they came into the world, or else passed down into the reservoir with the general stream and were never seen more.

The only vegetable-feeding mollusc which has laid eggs is the sea-hare, (*Aphysia*,) of which many large specimens, some of them 8 inches long, have been shown. These, after having been kept in captivity for some weeks, have deposited large masses of yellow strings of eggs, such masses containing millions of embryos; but, though seen under the microscope to be alive, not one has ever been

known to be reared into an aphysia, and the parents, indeed, have soon died. This depositing of ova appears to be the last act of their lives, as it is with moths and butterflies, and it is possible, and even probable, that the sea-hare is an annual animal. There is another group of animals nearly allied to the molluscs, but forming a separate out-lying group, called molluscoids, which have not only been born, but reared in remarkable profusion. Perhaps the most interesting of these are the famous molluscoids, called ascidia, famous at the present time, because from them Dr. Darwin has deduced the almost lineal descent of man. In tank No. 30, these ascidians may be seen standing up in no dwarf proportions; semi-transparent, whitish, double-necked bottles, down the in-current orifice of which one stream of water runs, while from the ex-current orifice another pours. The whole of these, hundreds in number, have been reared at Sydenham from masses of débris dredged at Weymouth, upon which, when obtained, were growing such annelides as the tube-worms, serpula and sabella; but curiously enough, no adult ascidians. These have all grown from larval forms, which, though invisible, must have been adherent to these masses, and they have been developed in captivity. This species of ascidia, which, from its translucency, is probably *Ascidia vitrea*, is so clean, and its walls are so delicate, that its internal structure may, in some instances, be seen through its outward envelope. This is never so with the specimens found at sea, which are much less clean and translucent.

It is one of the most interesting facts connected with the Crystal Palace Aquarium that not only has the same body of sea-water been used unchanged since the first stocking of the tank, but no filter has ever been used to remove impurities from the water. Such an adjunct has here for the first time been dispensed with, and this is, perhaps, one of the best testimonies to the perfectly scientific principles on which this aquarium is constructed. It will appear the more remarkable when we say that from August 7th, 1871, to September, 1872, 445 gallons of mussels, 608 quarts of shrimps, and 15 gallons of cockles have been introduced into the tanks as food for the animals. The greater part of this has, of course, been assimilated as food, but the débris and the excrementitious matter have been completely removed through oxidation by the finely-divided air driven into the tanks by the constant water-circulation. This operation has been so effectual that the floors of all the tanks are abso-

lutely free from all deposit or from decaying vegetation; for here, too, contrary to the practice of previously existing aquaria, the amount of light is so regulated that the vegetation is kept at its lowest point, and if all the vegetation used to decompose the carbonic acid exhaled by the creatures in the tanks were collected it would not weigh one ounce. In fact, except in one or two instances, it appears as the merest microscopic film, sufficient apparently to do its great work efficiently, but not enough to cause any appreciable quantity of deposit. This mode of employing a very small quantity of vegetation, and a very large amount of atmospheric air driven in mechanically, is in marked contrast with, and is a great advance upon, the earlier mode of dispensing with injected air, and employing a very large amount of vegetation. In the former mode, the vegetation had to be stimulated by exposing it to a large amount of light, and this caused the whole body of water to assume an opaque green color. Fresh-water tanks will shortly be stocked and put into operation in this aquarium. (53)

CALIFORNIA SALMON FOR EASTERN RIVERS.

DURING the past year, Mr. Livingston was engaged in California in packing salmon spawn for the purpose of stocking rivers in the Atlantic States. He was on the McCloud River in Shasta County, taking from 50,000 to 100,000 salmon spawn a day. The eggs are placed in boxes or vats, the wood of which has first been charred, so that the water may not be tainted by the boards. The eggs are kept in these vats for several days, with clear water running over them, during which time such as are worthless are separated and thrown away, and the remainder are carefully packed in layers of wet moss, boxed and otherwise made ready for shipment.

DIATOMS IN HOT SPRINGS.

DR. BLAKE has collected diatoms at a hot spring in Pueblo valley, Humboldt County, Nevada, the temperature of which was 163° F. More than fifty different species were recognized by him; and they were found to be mostly identical with the species found in beds of infusorial earth in Utah and described by Ehrenberg, showing that the latter must have been accumulated in a hot lake, of about the same temperature. No other living species were found in the hot waters, excepting red algæ. The deposit was a large one, and in it there were concretions of silica. On making a thin section of one of these concretions,

a pair of legs of a coleopterous insect were visible in the quartz; the greater part of the concretion was made up of petrified algæ.

In one of the hot springs at the California geysers, having a temperature of 198° F., he found two kinds of conferva—one capillary, resembling *Hydrocrocis Bischoffii*, but larger; the other a filament, with globular enlargements at intervals. In another spring, the temperature 174° F., many oscillariæ were found, which by the interlacement of their delicate fibres formed a semi-gelatinous mass, and also two diatoms. In the water of the creek of Geyser cañon, 112° F., the algæ formed layers sometimes 3 inches thick, covering the bottom of the pools, and the same diatoms were found as in the 174° spring. The waters are acidulated by the presence of free sulphuric acid; and Dr. Blake suggests that this may account for the rarity of diatoms.

MILK SEEN UNDER THE MICROSCOPE.

IT appears that from 100 parts of milk, containing 40·4 of butter, only 29·5 were obtained by churning, leaving behind in the butter-milk 10·9 parts; milk which is creamed under the most favorable conditions yet retains from 0·3 to 0·4 per cent of butter. By means of the microscope, cream, skim-milk, butter-milk, and whey may be perfectly well recognized.

WOOD SECTIONS.

I THINK many cuttings with low powers, and merely to show the general formation, are far better seen as opaque objects than as transparent ones. Some look very beautiful in this way, and more natural; besides, the color is seen. Nettle-root, apple ditto, and clematis canes, are amongst some which are well worth looking at. They must be thin, but not so thin as if used as transparent objects.—E. T. SCOTT.

ON NOCTILUCINE.

BY DR. T. L. PHIPSON, F.C.S.—I have given the name of noctilucine to a peculiar organic substance which causes the production of light in phosphorescent fish. This remarkable compound, which might almost be termed the *organic phosphorus*, is also the cause of the production of light by the glowworm, and probably by all other phosphorescent animals; it appears to be formed in a variety of circumstances at the expense of dead animal and vegetable tissue, and even by certain living plants.

At the ordinary summer temperature noctilucine is a

semi-fluid, almost liquid, substance containing nitrogen; it is white, and in its natural state contains a considerable amount of water; it has a slight odor, resembling that of caprylic acid; it is only slightly soluble in water, and is somewhat lighter than this liquid; it is insoluble in alcohol and ether, and is decomposed by acids and alkalies. Nitric acid easily dissolves and decomposes it; sulphuric acid, also, and potash evolves ammonia from it. In fermenting, in contact with water, it produces an odor of putrid cheese; as long as it is moist, it absorbs oxygen and evolves carbonic acid in the air. When left to itself it dries up, in the course of a few hours, to thin, shining, translucent films, quite devoid of structure, and resembling the *mucine* of the common garden-snail.

When recently produced noctilucine is highly phosphorescent, and this production of light is owing to oxidation in contact with the air. It also shines for a little time in water, as long as there is air in the water; it is rather more brilliant in oxygen gas, and still more brilliant in a south-west wind, which I find usually contains much ozone. This production of light ceases as soon as the oxidation is completely accomplished; but as long as the smallest amount of air adheres to it, it will shine, even in carbonic acid, for a short time.

Noctilucine is secreted in phosphorescent animals by a special organ, just as bile is secreted by the liver, and appears to be used in producing light nearly as fast as it is formed. It is also produced in certain conditions of temperature and moisture, in dead animal matter of various descriptions, (pork-flesh, beef, blood, fish, etc.,) and occasionally in urine. Whatsoever its source, it shows the same kind of light, nearly monochromatic; the same spectrum, principally developed between the lines E and F; and, as far as I have examined them, the same chemical properties.

In an impure state, noctilucine can be obtained from the surface of various fish when highly phosphorescent, also from the glowworm, by pressing the luminous matter collected by the scalpel through porous filtering-paper. It is secreted in a pure form by the luminous centipede, (*Scolopendra electrica.*) When a number of these *Scolopendræ* are caused to run about a large glass capsule, they leave a certain amount of noctilucine upon the surface of it, sufficient to enable one to examine the principal properties of this curious substance.

The secretion of noctilucine in the higher phosphorescent animals, such as the glow-worm and the fire-fly, is to

a certain extent dependent upon the nervous system of these insects; hence they have the faculty, apparently, of shutting off their light at will. In this case, the secretion is stopped for the time; but a certain quantity of noctilucine exists in the eggs of the glowworm, which also shine for some time after they are deposited.

There appears to be a special organ for this secretion of noctilucine, even in the minute *Noctiluca miliaris* of the English Channel, and other lower types of phosphorescent animals; and even here, where we find scarcely any rudiments of a nervous system, the secretion of the luminous substance appears to depend greatly upon external circumstances. (2)

A VISIT TO THE AZTEC CITIES OF ARIZONA.

MR. E. O. BEAMAN, who returned in September last from a photographic tour to the Arizonian Aztec cities, writes as follows from Colorado River, Arizona, to Anthony's *Bulletin*:

I will try and give you a short account of my trip to the seven Aztec cities of the deserts of Arizona, or, as they are more generally called, the Moquis Pablos. With one companion, a photographic outfit for about one hundred stereoscopic negatives, and about three months' supply of provisions and a few articles for trade with the Indians, I started out to see if I could find a country and people that had never yet been photographed. I will simply remark here, that I have now got my *satisfy;* I have done all the picture-making that I want to, for the present, of a people that do not appreciate the art. Our train consisted of three pack and two riding animals.

We struck out from here into an Indian country through which neither one of us had ever traveled, and over which but two or three white men have ever passed. We journeyed nearly two hundred miles over a rocky, sandy desert, relieved occasionally by a beautiful valley well watered, but in many places we went fifty and sixty miles without a drop of water. We passed through several camps of Navajos, whom we found very friendly. To describe to you the romantic, strange appearance of these antiquated cities of the descendants of Montezuma is far beyond the power of my pen; but, with the few facilities at hand, I have finished a few prints and inclose them with this letter, trusting that they will speak more eloquently than I can.

The country through which the Green and Colorado rivers pass, you are probably aware, is in many places strewn with broken crockery of beautiful workmanship

and painting; the cañon walls are in many places covered with hieroglyphics, whose meaning is totally unknown to the Indians now inhabiting these regions. These signs of a once powerful and semi-civilized people are plainly traceable to the Aztec cities, the inhabitants of which do not now number over two hundred souls. This people, dwelling in houses three and four stories high, and peace-loving and intelligent beyond any other tribe that I have ever met with, are nevertheless very superstitious, so much so that I have found great difficulty in making negatives of them without getting myself into trouble.

They looked upon pictures that I made of their houses with wonder and amazement; and, when I presented them with some of my best efforts in the way of photographs of themselves, so soon as my back was turned they were immediately destroyed or thrown away. Had they been warlike, I presume that I should have come away minus a small lock of hair; as it was, I was politely requested to leave their towns. Nearly all the groups that I took of them are instantaneous views, or taken when they were not aware of what I was doing. They evidently look upon a picture as a sure passport to the happy hunting-grounds of another world. The towns are built upon high hills or plateaus of solid rock, twelve to fifteen hundred feet above the valleys, and are about two or three miles apart. In the valleys they herd sheep and cultivate corn, melons, pumpkins, etc. The towns are fortifications within themselves. You enter the houses by ascending a ladder to the top of the first story, and then descend by a trap-door to the other floors, by means of stone steps. On pulling up the ladders, the houses are easily defended from an attack by Indians. They are built of rock and mud, with walls two and three feet thick. The Aztecs are very friendly and hospitable; when visiting a neighbor they always put before you something to eat, which generally consists of vegetables and mutton stewed up together, also bekah (bread) and melons. Knives and forks are a superfluity; they eat by sticking their fingers in one common dish and sucking them, and *you* are expected to do the same. Their bekah is made of corn meal, and very much resembles scorched brown paper, but is very sweet and nutritious. On our return we came within a few miles of the San Francisco Mountains, from whence heads the Rio Colorado Chiquito, or, as it is more generally known, Flax River. There have been many rumors of diamonds having been found in that country. All that I found did not trouble me much; and, as the Apaches are in that range of mountains, I did not waste much time in that vicinity.

BRITISH MUSEUM PHOTOGRAPHS.

THE British Museum has long ago made good its title to the foremost place among national collections of its class. Nor is this supremacy due alone to the encyclopedic character of its contents. It is even in higher degree owing to the unsurpassed excellence of the objects which it has to show in well-nigh every department.

An enterprise lately set on foot with praiseworthy spirit will henceforth place within the scope of ordinary means a series of the masterpieces of the national collection. By the sanction of the trustees, and with the aid of the principal librarian, nearly a thousand plates have been taken of objects selected by the several heads of departments, which may be looked upon as typical specimens in each class. It has been stipulated that the price of each print, varying in size from 12 by 10 to 10 by 8 inches, shall not exceed two shillings unmounted. The complete set, comprising 929 mounted photographs in twelve portfolios, (gratis,) is to be purchased for £116 2s 6d., or bound in twelve handsome volumes, in the highest of three optional styles, for £143.

The full series of photographs, made up of seven parts, is designed to exhibit evidences of man's advance from the earliest known stage of his history, with the gradual development of social life and usage, of belief, science, and artistic culture, to their highest or latest standards.

Exact chronology in the case of the rude objects which betoken man's earliest presence upon the earth is, of course, out of the question. In presenting, however, a selection of unpolished stone implements from the drift at Hoxne, Herne Bay, Gray's Inn Lane, and Abbeville, it can not be questioned that the series before us carries the mind back to as remote and rudimental a period of man's being and intelligence as we have the means of figuring to ourselves. Other groups of chipped flints, some bearing unmistakable marks of wear, from Poitou, the Aveyron, and elsewhere, furnish no less typical specimens of prehistoric handicraft. Plates 5 and 6 show seventeen harpoon heads of reindeer horn, some barbed on one side, others on both sides, probably used in fishing, from a cave near Bruniquel, Tarn et Garonne.

To the same paleolithic, or first stone period, belong the needles and other instruments, chiefly of horse's bone, together with divers bones showing figures of animals rudely etched, which form a succession of interesting plates. Most noteworthy of all must be thought the rough but expressive figure of a mammoth (Plate 10) carved in reindeer horn, as the handle of a poignard, from

a cave at Montastruc, near Bruniquel, photographed from a cast in the Christy collection. We fail to see the not less curious etching of the side view of a mammoth on a large bone, apparently of the urus, which, unless memory deceives us, is also to be seen in the Christy Museum. These rude drawings are of infinite value as unmistakable proofs of man having lived in company with the mastodon and other long extinct mammals. Three casts of skulls found in a cave at Cro-Magnon, near Les Eyzies, Dordogne, (Plate 12,) exhibit probably as early remains of man himself as research has disinterred from their resting-place of ages. It is interesting to compare with these the modern carvings in walrus-ivory, horn, and wood, (Plate 91, Ethnographical Series,) by natives of the North-West Coast of America. We may further, by the aid of the same series, study side by side the earliest prehistoric flint flakes from the glacial drift with implements used at the present day by the Arctic tribes or Pacific islanders. Here are proofs of the persistence of the most archaic and simple forms of human art down to the present day. Intermediate forms may be instructively seen in the implements of the neolithic or polished stone period, and that at which bronze, and subsequently iron, came into use. Picks from antlers of red deer, probably used in getting from the chalk the material for flint weapons, implements, or ornaments, (Plate 18;) hammers, pierced probably with a wooden drill worked with sand and water; knives, scrapers, and arrow and javelin heads of flint, together with the cores from which they have been chipped, (Plate 21,) are fair and graphic illustrations of primeval art.

Passing from the prehistoric to the historical period, we find ourselves first upon firm and solid ground among the mighty monuments of the Nile valley. The wealth and variety of materials furnished by the Egyptian Department of the national collection enables Dr. Birch to illustrate the earliest authentic stage of civilized life with a degree of fullness of which none other is, perhaps, equally capable. What particularly arrests the eye is, probably, the high pitch of artistic skill and domestic comfort at which the Egyptian is thus early seen. Porcelain tiles dating as far back as the second dynasty, (Plate 286,) a glass perfume-bottle, bearing the name of Thothmes III., eighteenth dynasty, (1450 B.C.,) the earliest glass known with a date, (Plate 283,) a wooden board with hieratic inscription, a treatise on grammar and rhetoric for the use of a school, written about 1800, (Plate 280,) mural paintings and tablets in tempera, almost without

number, depicting scenes of domestic life, agricultural work, sporting, music, and dancing, royal triumphs, rites of religion and care of the dead, bring before us every phase of a national life which reached its culminating point some thirty-three centuries ago. Arranged as far as may be in chronological order, and grouped systematically as connected subjects, these expressive plates furnish a pictorial history in which the native and original elements of art and thought can be traced without a break till they wane and are superseded under the influence of foreign and intrusive styles. Another great and independent well of civilization is opened up among the newly recovered treasures of Assyria and Babylonia. It is in this department that one main design of the present publication is most signally to be realized. The magnificent series of inscribed slabs, cylinders, and tablets may be studied by the aid of these clear and well-defined photographs with a facility greater even, in some respects, than is possible within the walls of the museum itself. Students of cuneiform writing will find here examples in almost endless number and variety, admirably selected and classified. Not to speak of the sources of historical knowledge to be opened up in the records of the realm, with the codes of law or domestic usage, it were sufficient to point to the series comprising an entire grammatical encyclopedia from the library of Asshurban-i-pal, (667 A.D.,) of which an analysis is given in Mr. Harrison's introduction. Arithmetic, astronomy, a methodical pharmacy mixed with a less scientific system of incantations, have a place in this characteristic literature. Fractions are to be recognized, with the denominator 60, the sole representative of the decimal and duo-decimal scales; and (see Plates 559, 560) even algebra and square roots. The master works of Greek genius, in which the museum is transcendently rich, are too well known to be easily singled out for notice. We need say no more than that the Panathenaic series from the Parthenon appears entire, as do all the colossal, though sadly fragmentary, glories of Phidias from both eastern and western pediments, with the grand remains from the Mausoleum, etc. The associated groups and examples of sculpture exhibit the contrast or change of feeling characteristic of successive periods of Greek art, whether at home or in the colonies, as well as its points of affinity and contrast with the arts of Egypt and the East, which the tyro will find succinctly and clearly drawn out for him in the introduction. Apart, however, from such educational functions, the choice array of specimens here brought together

have a charm of their own as embodying types of supreme beauty. Engraved gems, bronzes, vases of the archaic and later periods, with delicate works in terra-cotta and glass, find in the photographic process a medium peculiarly fitted for effective display. The same delicacy of representation, with no less feeling and knowledge in selection, is shown in the later portions of this choice collection, which hands on the lamp of artistic skill and culture to our own shores and to the present day. It is impossible by any process of selection to do justice to the profusion or to the significance of the varied objects which make up this handsome contribution to the literature of art. (18)

FOSSIL MONKEYS.

IN view of the discussion on the antiquity of man, and his probable descent, it will not be uninteresting to notice those quadrumanous animals which stood highest in the natural history scale before man made his appearance, and the relative epochs at which they lived. From the following brief notes on an article in the *Annals of Natural History* for September, it will be seen that some of the existing genera of monkeys have a great antiquity. The greater part of the fossil monkeys known up to the present day belong to the miocene deposits. Dr. Falconer was the first to find them in the miocene strata of the Sewalik Hills in Northern India, in 1836. In 1837, M. Lartet communicated to the Academy of Sciences the discovery of a quadrumanous animal in a miocene fresh-water deposit at Sansan, which was subsequently named *Pliopithecus antiquus*. An allied species was found in 1862 in the fresh-water strata of the molasse, in the canton of Zurich. This form, however, does not approach the anthropomorphic ape so much as the preceding. In 1856 M. Lartet described another anthropomorphous ape, which he named *Dryopithecus*. So much did the teeth of this species resemble those of man that they have been frequently mistaken for human molars. M. Fraas also described a species of fossil monkey from the miocene bed of Steinheim, in Würtemberg, which he believed belonged to a species of *Colobus*. It is in the Pikermi deposits in Attica, Greece, that the most numerous remains of monkeys have been found, but always confined to a single species, called *Mesopithecus pentelici*. Of this, M. Gaudry sent to Paris the remains of no fewer than twenty-five individuals. Another miocene monkey has been found in the sands of Eppelsheim, of the same age as the Pikermi beds. In deposits newer than the miocene, the *Macacus pelioc*œ*nus* has been found

in the brick-earth of Gray's Thurrocks, Essex. The remains of another species, called *Semnopithecus monspessulanus*, have been found in the fresh-water marls of Montpellier, of pliocene age. Another species, met with in the same beds, has been named *Macacus priseus*. Lastly, in the Brazilian bone-caves, five species of platyrrhine monkeys have been found, showing that the American type has been long in existence. One form, *Protopithecus brasiliensis*, surpassed in size the largest of the living American monkeys, the *Mycetes*, with which it had some relations. Altogether, nineteen species of fossil monkeys have been described. The eocene deposits have as yet only furnished one species, of which the determination is certain. Until quite recently, fossil monkeys were unknown in the different fossiliferous formations of Italy, but Dr. C. J. F. Major has just described one belonging to the genus *Macacus*, which is nearly allied to the European form now inhabiting the rocks of Gibraltar. This fossil is believed to come from the Val d'Arno, and of pliocene age. The animal was a contemporary of the *Elephas meridionalis*, *Rhinoceros etruseus*, etc. Another monkey, a *Cercopithecus*, is also announced as having been discovered in the lignite of Monte Bamboli, in Tuscany. Still another is represented by several teeth, etc., in the Pisa museum, from a pliocene lignite in the Val d'Arno. It will be seen, therefore, that if we are descended from the monkey family, we have more than one stock to choose from in the construction of our genealogical tree.

(16)

THE GRAND CANON OF THE COLORADO.

ABOUT the first of January last, Major Powell, accompanied by John R. Stewart, of Kanab; Captain Dodd, formerly of the Uintah agency, and G. W. Riley, a Snake River miner, left Kanab to discover a pass into the river, whereby supplies might be sent to the expedition while on its downward trip during the ensuing summer. They found their way in by following the Kanab Wash through a deep cañon, very narrow—in some places not over fifty feet wide, with vertical and overhanging walls twenty to twenty-eight hundred feet high—almost closing in at the top in some places, and turning the brightest day into twilight, filling the beholder with awe and wonder at the marvelous works of nature.

Down the cañon flows a beautiful stream of clear cold water, obstructed in its course occasionally by a pile of huge bowlders, through which it goes dashing and foaming, forming cataracts and falls too wonderful and grand to be

described. The entrance of this cañon to the Colorado they found to be about seventy-five miles distant from Kanab. While here Riley discovered gold. He returned in a few weeks with an outfit, accompanied by others, and there was soon great excitement in Utah; large parties of miners and saints were suffering badly with the gold fever, and soon on their way to the new Eldorado. Many, however, have been doomed to bitter disappointment, as the gold is of that quality known as float or flour gold, which is impossible to save without the best of copper plates, with acid and quicksilver for the rockers.

The scenery here on the river is very fine, the vertical walls near the river being from three to four thousand feet. Above them are other plateaus or benches, making it over a mile high from the water to the top of the cañon walls.

The Buckskin Cascades.—The falls are caused by a small stream of water coming in from the Buckskin Mountains, and are fed by springs. The cliff through which it comes is about four hundred feet high; but the stream having worn a narrow crevice down into the rock about one hundred and fifty feet from the top, now falls fifty feet and forms a basin or alcove at the foot of the cliff; from thence it finds its way into the boiling Colorado, two hundred yards away, over several beautiful little falls from six to ten feet high. The walls of the cliff around the cascade are covered with fern, moss, and wild vines. I succeeded in making a dozen fine negatives. We found the ruins of several stone houses near the Buckskin Cascades, right under a vertical wall that towered into the sky at least four thousand feet; it looked as though people might have been living here in a state of siege. On the wall of the crevice, I found the print of a woman's hand, which appeared as if it might have been painted with water-colors. These and many other signs bearing marks of great age point this out as having been the retreat of the Moquis Pablos, or Aztec Indians, whose villages are about one hundred miles south of here. (12)

COLORED GLASS IN MICROSCOPY.

M. MOUCHET, in advocating the use of colored glasses in microscopy, for the purpose of saving the eyesight, reviews carefully the various positions in which they may be placed; these are four in number—before the mirror, under the object, between the objective and eye-piece, and lastly, above the eye-piece itself. The most convenient position seems to be above the eye-piece. For this purpose M. Mouchet has constructed a revolving diaphragm pierced with nine openings, each one centimetre in diameter.

Seven of the openings are fitted with colored glasses corresponding to the tints of the solar spectrum; another with a silvered glass, according to Foucault's process; and the ninth with a very finely roughed glass, which may be removed at will, and thus leave one opening free. This revolving diaphragm is attached to a ring placed on the tube which receives the eye-piece.

SNAKE CULTURE IN LONDON.

THE eminent English zoölogist, Mr. Frank Buckland, relates the following: Snakes are regarded with horror and repugnance by the generality of mankind and womankind, and for this reason their habits and instincts have not been sufficiently studied. Snakes may be broadly divided into poisonous and not poisonous. As a rule, poisonous snakes will get out of a man's way if not attacked or insulted. I do not recommend people trying to tame poisonous snakes, nor do I advise them to charm them after the fashion of Indian jugglers, though, as has been often shown, these poisonous snakes are generally 'doctored,' as regards their fangs, before the exhibition takes place. There is now a gentleman in London who has a charming family of pet snakes—harmless, of course. This gentleman's name is Mann. He is a professor of music, and lives in Cheyne Walk, Chelsea. Mr. Mann called on me a day or two since at my office, and requested me to give him assistance, as he had got into a bother with his neighbors about keeping his snakes.

Anxious to be of service to this gentleman, I called at the house, in order to examine his snakery. He placed in the middle of the room a large box, which was carefully locked. He told me the box was always locked, unless he or his wife took out the snakes to feed or examine them. The first he produced from the box was a very fine common British snake, (*Coluber natrix.*) His snakes have all got names, and this one's name was Julia. Julia had long ago laid thirty-six eggs, which were hatched out successfully. The next was also a common British snake. The ring around the neck was very bright in this snake. She rejoices in the name of Sylvia. Sylvia is very good at frogs; lately she ate nine frogs, seven large frogs, and two small, at one meal, one after the other. Mr. Mann has also two other common snakes, whose names are Proteus and Beatrice, or she of the golden hair. This modern snake-charmer then dived his hand into the box, and brought out an exceedingly lively brown-colored snake. The head is remarkably pretty and lizard-like, and it has the power of moving the head very quickly

from side to side; the eye is also remarkably brilliant. This snake was brought from Jamrach; it is called a Lacertine, and comes from the coast of Mogador, Northern Africa; it is perfectly harmless. Mr. Mann has had the Lacertine about twenty months. It is a pretty, elegant creature. It feeds on white mice.

"Mr. Mann then showed me the gem of his collection. It is a remarkably handsome Brazilian boa, measuring between five and six feet long, and weighing from twelve to fourteen pounds. The name of this snake is 'Cleo,' short for Cleopatra. Continual handling and petting has caused this snake to become most remarkably tame, and I think there can be no doubt she knows individuals. When placed on the table, Cleo would not come to me at all, but glided away to her master, who was sitting at the opposite side of the table, and stretching her body from the table to the chair gradually pulled her long length on to him. She then glided up his right side, and folded her coils around his neck, placed her head close to her master's face, and there she lay for some minutes, quivering her black forked tongue with evident pleasure. Mr. Mann's two little children, aged five and six respectively, then came into the room. They immediately ran to the snake and began playing with it, kissing it and pulling it, calling it 'Cleo; dear Cleo.' Cleo was then made to glide on the floor; the children ran after her and picked her up, and the little girl, picking her up, put her round her neck like a *boa*. (I wonder if this was the origin of the word boa?) Cleo evidently enjoyed the fun as much as the children. It was very curious to see these two children encircled in Cleo's ponderous folds, reminding me much of the celebrated statue of the Laocoon, and, if I recollect right, the marble children in the statue are represented as about the same age and size as Mr. Mann's two children. Cleo is a particular favorite of Mrs. Mann's, and I saw a very nice photograph of her with Cleo coiled around her neck. I subsequently saw Mrs. Mann in this attitude with her pet snake. Cleo has shed her skin several times, and it is curious to remark that she shed her skin ten times in two years. Mr. Mann has the last skin shed. It is quite perfect, and as thin as tissue-paper; and I should think would make a good pattern for fancy lace-work.

"Cleo feeds principally on pigeons. If a pigeon is put into her cage, and she is not hungry, she seems to make friends with the pigeon, and will never attempt to eat it. Should, however, a fresh pigeon be put into her cage, she will devour it instantly. She feeds once a fortnight, and

two pigeons will last her for that time. Mr. Mann has observed that, when let loose, Cleo always tries to climb upward, whereas the Lacertine always seeks the ground. Cleo most certainly knows her master and mistress. Once when they went out of town, Cleo was left behind. She pined and would not feed during their absence. When Mr. and Mrs. Mann returned, after six weeks' absence, Cleo, on hearing her mistress's voice, instantly rushed out of her box, coiled herself around her, and kissed her face. She evidently recognized her kind friends and protector.

"Mr. Mann has also another large Indian python, but this snake is not very well, and has private apartments to itself in a leathern carpet-bag. The snake will feed out of Mr. Mann's hand. The common snake eats frogs only; the Lacertine eats white mice; the python delights in guinea pigs. Altogether, I was exceedingly pleased with Mr. Mann's collection of snakes. By his very successful snake-taming he has opened up quite a new chapter in natural history, and has shown what persevering kindness will do in taming snakes, poor creatures, which have hitherto been thought to have little or no intelligence."

(38)

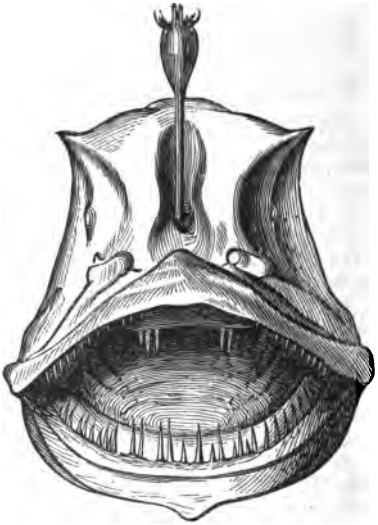
RATTLESNAKE POISON.

THE process of extracting the poison from the rattlesnake (*Crotalus horridus*) for medicinal purposes, while the reptiles were still living, has been successfully accomplished by Mr. J. C. Thompson and Dr. Hayward, of Liverpool. The following was the *modus operandi:* The reptiles were in separate compartments of a large case, fitted with a double lid for extra security. A long staff fitted with a thick India-rubber noose at the end, which could be loosened or tightened by the hand at pleasure, was inserted through the partially opened lid, and the opportunity quickly seized of slipping the loop over the snake's head, the loop being immediately drawn tight by means of the cord attached thereto. With a similar contrivance the tail was next fastened, and the snake, being thus securely held, was lifted out of the box on to the floor of the room. A pickle-bottle containing chloroform was then thrust over the snake's head, and carefully held in its place by keeping time to the animal's efforts to extricate itself. As the reptile became stupefied, the noose was gradually relaxed to enable the lungs to have full play, and when it appeared powerless, the snake was laid in a long, narrow box made for the purpose, with an aperture at one end, out of which its head projected while the after-operation was performed. Its jaws were then

opened and fixed, and the poison glands were pressed with forceps, then with the gloved finger and thumb, while a small, blown, graduated vial was held to receive the drops as they slowly oozed out through the poison-fangs. Twenty drops were the average quantity yielded by each snake. The venom is of a straw-color, thick and gummy in consistency, and decidedly acid in its reaction on litmus-paper. It is readily soluble in glycerine or water, but is precipitated by strong alcohol, the precipitate being redissolved with the addition of a little water. Its toxicological properties were fully tried on a variety of animals. Half a drop produced death in a linnet within three minutes after being injected under the wing. (16)

A NEW FISH FROM GREENLAND.

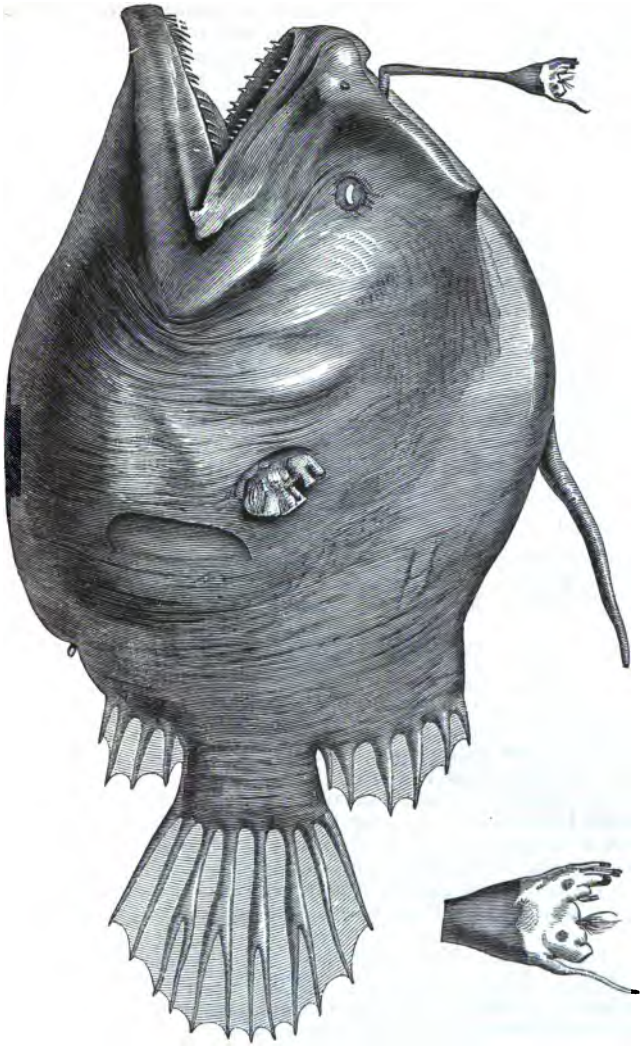
SEEN from the side the outline of the fish nearly forms a tolerably regular oval, somewhat pointed in front, (in the facial part,) but with the snout itself truncated, and posteriorly (at the root of the tail) somewhat produced. Seen from before, its physiognomy is very peculiar. The *head* is quadrangular, with a broad, sloping, frontal surface, which is hollowed out by a broad and deep furrow, and bounded at the sides by an incurved wall which projects strongly behind and above on each side in an acute frontal spine, and anteriorly and beneath, on each side of the apex of the snout, runs out into a double tubercle. Immediately over the rostral tubercles a small nasal papilla may be observed on each side.



HEAD OF ONEIRODES ESCHRICHTII.

The total length of the fish, from the snout to the apex of the tail, is about eight inches; the greatest depth, which will about coincide with a line dropped from the isolated soft dorsal ray, over the point of attachment of the pectoral fin to the ventral margin, is about four inches, con-

A NEW FISH FROM GREENLAND. [ONEIRODES ESCRICHTII.]



sequently fully half the total length. The thickness, measured between the two frontal spines, and between

the angles of the mouth, about two inches, consequently approximately one fourth of the total length; and this applies also to the length of the jaws, (about two inches,) to the height of the fully expanded mouth, and to the distance from the apex of the snout to the frontal spines, or from the latter to the angles of the mouth. When the mouth is shut, the apex of the lower jaw falls within the upper jaw. The *eyes* one would perhaps expect to occur in the deep depressions at the sides of the head under the lateral walls of the forehead; but they are to be found rather further back, at the boundaries of these depressions; they may easily be overlooked, partly because they are very small, partly because they are nearly hidden under the skin, which forms over them a small, white, translucent, oblong spot. An eye-cleft does not seem to be present.

At a small distance from the apex of the snout, in the lowest (foremost) part of the cavity of the frontal surface, there is inserted a *frontal ray* (first dorsal ray) of an extremely peculiar form. The free part of this ray is about an inch and a half in length; when laid back, it does not extend beyond the frontal pit; it consists of two parts, the "shaft" and the clavate "head," which are both compressed; and the shaft is attached by a kneed joint to a similar horizontal piece which projects only by its outermost skin-covered part from the channel between the forehead and the skin which serves as its bed.*

MICROSCOPIC LIGHT-CORRECTOR.

R. COLLINS has devised an ingenious apparatus for this purpose, consisting of a brass stage-plate with a groove, in which rotates a diaphragm of four apertures, one of them being open, and the other containing blue glasses of special tint, and one with a finely ground surface. These effectually correct the yellowness of all artificial illumination, making the light soft and agreeable to the eyesight, as well as improving the definition. It is, in fact, an improvement on Rainey's light-modifier, so as to obtain more varied effects, and does not require any special fitting, as it can be used on any microscope.

*I am not in a position to indicate the purpose of this singular structure; but I will not conceal that the whole arrangement has above all produced a "mimetic" impression upon me, as if it were intended to resemble, *e. g.*, the head of a Nereid; and I have been compelled to think of the old notions of the employment by the fishing frog of its homologous frontal appendage as a means of attracting other fishes, which, indeed, have given origin to its scientific specific name.

WHY BUTTERFLIES AND MOTHS ARE SCARCE AFTER A DAMP WINTER.

THE circumstance that a cold and dry winter is more favorable to the development of lepidopterous insects than a mild and wet one has been variously explained; and there is no doubt that several causes are concerned in it. The effects of excessive moisture upon pupæ, it has been already noted, are decidedly unfavorable, and kill many which would defy severe frost and its accompanying dryness. Mildness in the winter season is harmful to a certain portion of the hybernating caterpillars. It is the general habit of some of these to feed through the winter at intervals, and others remain almost invariably quiescent, waiting for the development of vegetable life in spring. These latter are roused from their torpor by an unseasonable geniality. They seem to require food, but, in some cases, there is none to be had appropriate for them; and they often die from inanition, or are killed by some change of the weather. Eggs also, which should remain unhatched until March and April supplied the leaves needed by the larvæ, are developed into life in February, or even in January, and the result is necessarily the death of the particular broods. So that, looking at the matter from a horticultural point of view, the gardener, if he grumbles for some reasons at a wet and mild winter, has also reason for satisfaction thereat, in the probable diminution of the number of caterpillars which will annoy him in the following summer. (16)

THE POTATO DISEASE.

IN the vast majority of instances the fungus makes its *first* wholesale attack upon the *leaves*, sending its destructive mycelial threads down the leaf-stalks into the stem, and thence, and lastly, into the potato itself. If this takes place when the potato-plants are young, growth is at once arrested; but if the plants are well established, the tubers are found to be discolored. This is undoubtedly caused by the presence of the fungus beneath the cuticle of the potato; for if the potatoes are taken up and kept in a damp air for a day or so, the perfect parasite presents itself upon the surface. From the exterior of the potato the fungus penetrates to the interior, decomposing the tissues, and making the tuber a suitable nidus for various other fungi, which are not long in making their appearance. With the decomposition comes the disgusting odor so well known in connection with diseased potatoes; the diseased tuber is now attacked by insects, and its end is one horrible fetid mass. It generally hap-

pens that the eyes are the last to succumb to the disease; and it is stated that if these are cut out and planted, they grow into healthy plants; but if the fact is taken into consideration of the resting spores being produced within the intercellular passages of spent potatoes, and that these resting spores are capable of lying dormant during a whole season, it seems reasonable to imagine that the planting of such eyes would be the one *certain* means of spreading the disease.

That the fungus attacks apparently healthy plants there can be no manner of doubt, the prevailing opinion now being that it is by *no means necessary* that a plant should be in ill health for a fungus to find thereon a suitable nidus. Contrary opinions have, however, long been held, and are still held on this point, many observers thinking that excessive moisture, over-cultivation, (if such a thing be possible,) electrical influences, or attacks of insects, first affect the health of the plant, and predispose it to succumb before the attacks of the fungus. Mr. Alfred Smee, surgeon to the Bank of England, has long held his ground upon the hypothesis that the potato is first attacked by an aphis, and so rendered a ready prey to the *Peronospora*, and says from his own observations he believes that an aphis invariably punctures the leaves before an attack of the fungus; he holds the same views with respect to the *Ascomycs* of the peach; but Berkeley and others nail their colors to the fungus, the whole fungus, and nothing but the fungus, and not without sufficient grounds; for, among other reasons, the immediate allies of the potato fungus do not prey upon decaying matter; other species of fungi do, but *these do not*.

While it is comparatively easy to say when and where the potato murrain was first brought prominently into notice, and what the potato disease is, it is by no means an easy matter to suggest an effectual antidote to its ravages. Dr. Hooker has recently published in the daily papers a plan devised by Professor Henslow for preserving the nutritive portions of diseased potatoes; but, from its tedious nature, it is never likely to be carried out to any extent, or made use of by the people at large. When the disease first appeared, a quarter of a century ago, it was suggested that the moment it became manifest in the leaves the whole crop should be mown down and burnt before the destructive virus reached the tubers. Now, after all this lapse of time, no better plan can be suggested; but such is the rapid growth of the fungus, that unless the haulms be destroyed *immediately* on the appearance of the parasite, it will be *too late*: if a week or less

be allowed to elapse, the mycelium will be in the tubers, and all the haulms a rotten mass. (16)

A NEW SPECIES OF PROTOCYSTIS.

DR. WALLICH in a paper on some undescribed testaceous rhizopods, read before the Royal Microscopical Society, publishes a new genus of rhizopods, which he had discovered in the North-Atlantic soundings. This genus, he says, "is very scarce in the deposits, and he had not been able to detect a single specimen in which the sarcode body was even partially visible, although, from the general appearance and characters of the silicious shell, it seems highly probable that they are related to the genus *Cadium*, Bailey. They exhibit one striking peculiarity, which is sufficient to warrant their being provisionally placed in a separate genus. I allude to the possession of a process which, in one variety at least, appears capable of being detached from the main body of the shell, as if it were constituted of a distinct and separate portion. To this genus I have given the name of *Protocystis*, leaving the exact nature of the sarcode body of this genus and of *Cadium* to be determined when an opportunity of examining their living tissues shall have been obtained."

AN EIGHTIETH OBJECTIVE.

AT a recent meeting of the Quekett Microscopical Club, held at University College, Mr. Thomas Powell attracted considerable attention by the exhibition of an eightieth of an inch object-glass made by himself. Of course, under the circumstances of its being exhibited in a public room, it was not possible to test this glass very severely, but it appeared to perform well, defining the podura test sharply and without color, and having plenty of light. Its magnifying power is 4000 diameters with the A eye-piece, with an angular aperture of 160°; it bears the B and C eye-pieces, with no other detriment than some loss of light, and works well through covering glass ·003 thick. Should Mr. Powell be able to produce these glasses, they promise to be an important addition to our microscopic powers.

FOSSIL HORSES.—At a meeting of the California Academy of Sciences, it was stated by Professor Marsh, of Yale College, that in the miocene and pliocene deposits of East-Oregon a large number of species of fossil horses had been discovered. Among them was one only two feet in height. Others of the two-toed type had also been collected.

PRESENT APPEARANCE OF THE FALLEN MONARCH.—SHOWING THE AUGER-HOLES AND HOW IT WAS FELLED.

THE BIG TREES OF CALIFORNIA.

It was not until we had ridden round several of the largest, says Mr. J. H. Bromley, and, sitting upright on our horses, had ridden through the hollow, burnt-out trunk of one, a section of which lay lengthwise in the trail, and had come down by the side of the "Fallen Monarch," which lay on the ground where it fell, that their full meaning dawned upon us and we realized their tremendous size.

Sitting there by the side of this prone monarch, and measuring its diameter in my eye, or climbing up twenty-five or thirty feet upon its side—comparing it in my mind with the largest trees I had ever seen elsewhere—imagining it stretched out in some city street, filling all the carriage-way and reaching up to the second-story windows—the idea of its vastness took full possession of me, and for the first time I grasped its greatness. And even then I do not think the idea of size and measurement so over-

whelmed me as did the thought of its vast age and the centuries it had looked down upon. The great space it had filled was nothing to the ages it had bridged over. No inanimate monument of man's work was here—no unwrapping of dead Pharaohs from the mummy-cloths of the embalmers; but here had been life and growth and increase, and running out of roots, and spreading forth of branches, and budding leaves, and flowing sap, and all the processes of nature with poise and swing from winter's sleep to summer's waking, and the noiseless registering of the years and centuries in figures that could not be mistaken from the heart of the sapling out to the last rind of bark that hugged its age. And though one looks with profoundest wonder at the vast size of these monsters, it is, after all, the suggestion they give of their far reach backward into time that most impresses the beholder.

The rings in the trunk indicate ages varying from a few years to upward of two thousand. Those of about ten feet in diameter are in the neighborhood of 600 years old. Most of the largest trees have been damaged more or less by fire. One of them has been entirely hollowed out, so that our whole party of twelve rode in upon our horses and stood together in the cavity. The tree grows on, and is as green at the top as any of them, notwithstanding the hollowness of its trunk.—*Scribner's Monthly.*

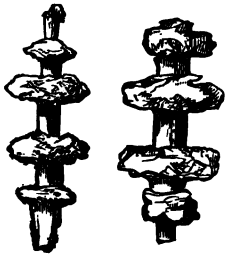
MASTODON BONES.

AT a meeting of the Cornell Natural History Society, Mr. Seybolt read a paper on the skeleton of the mastodon exhumed on the farm of A. J. Mitchell, near Otisville, Orange County, N. Y. The facts of the case were drawn from the personal observation of the speaker, and were consequently listened to with much interest. The skeleton was discovered December, 1871, in a deep wet swamp. The bones found up to the 1st of April were the ribs, vertebræ, head, pelvis, and bones of the fore legs—indeed, all the bones, except those of the hind legs, lower jaw, and tusks, which undoubtedly will be found ere long. The head is of astonishing size and measures three feet seven inches across the top and over four feet in length. Of the teeth, the back tooth extends seven inches along the jaw, and has a width of three inches. The tusk-holes are seven inches in diameter and extend three feet into the head. The shoulder-blades are each two feet in length and about the same in breadth; and the ribs, some thirty in number, measure in the longest between five and six feet. The pelvis bone, which was taken out entire, measures in its greatest extent five feet seven inches.

The skeleton, as a whole, is supposed to be the largest yet discovered. When set up it will be fourteen feet in height and twenty-five feet in length. Twigs of coniferous trees, leaves, and other vegetable matters, were found between the ribs, and tufts of dun-brown hair from two to seven inches in length were found outside.

JUKELLA CRISTATA.—A NEW ALCYONARIAN.

By Dr. J. E. Gray, F.R.S., etc.—Coral hard, fleshy, forming a thick, smooth, barren stem, marked by irregular longitudinal grooves or ridges; divided at the top into irregular transverse foliaceous expansions, sinuated or lobed on the margins, which are covered with close retractile polypes on each of their sides. All parts of the coral studded with calcareuos cylindrical spicules, which have four more or less large, prominent, separate, transverse plates, which are largest in the middle and more or less small or rudimentary at the ends. *Hab.* Sir C. Hardy's Island, South-Pacific. Presented by J. B. Jukes, Esq. British Museum.



Attached to a shell and part of a rock. The stem is about four inches high ; and the crests, of very irregular form and size, are nearly parallel to each other, as if placed across the fleshy stem. (31)

ANCIENT INHABITANTS OF UNALASKA.

At a meeting of the California Academy of Sciences, Dr. W. H. Dall, of the United States Coast Survey, gave some account of discoveries made by him on the Island of Unalaska, where, in excavating, he has found the remains of seven ancient villages, together with knives, needles, and other household utensils. In a tomb near the sea, evidence was found that prehistoric Aleuts preserved the remains of their dead by removing their viscera, stuffing the bodies with dry grass, and drying them. The corpses were then placed in dry caves, dressed as in life, ornamented gayly, and covered with carvings, the most remarkable of which were large masks painted of different colors and ornamented with feathers, tufts of hair, and bristles of deer. Sometimes the bodies were placed in natural positions, covered with carved wooden armor, or seated in miniature canoes or arks, and equipped as if for hunting or holding a paddle. These discoveries were made in places which, it had hitherto been supposed, were never inhabited.

METEOROLOGY AND TERRESTRIAL PHYSICS.

THE LAST ERUPTION OF VESUVIUS.

THE scientific results of the late eruption of Vesuvius promise to be as important to science as the phenomena were grand and awe-inspiring to the spectator. Not only has Professor Palmieri published an account of the observations from his dangerous stand-point, in Italian and German, which will shortly make its appearance here in the English translation, by Mr. Mallet, but M. Henri Saussure has also published in the Geneva *Bibliothèque Universelle* an account of an excursion made by him to Vesuvius about the middle of last May, shortly after the violent eruption of April.

Vesuvius, as Prof. Phillips has taught us, was formerly a mountain forming a vast circle, whose central part, occupied partly by a crater—which, without doubt, has been often displaced within the limits of the circumference—was not less than two miles in diameter, and the projecting part of which, occupied at present by the cone, formed then only a kind of plateau. The famous eruption of A.D. 79, which happened unexpectedly after a very long period of repose, entirely changed the form of the mountain. Very little lava seems to have been given forth during that eruption, which was characterized by tremendous showers of stones and ashes, and by rivers of mud. This it was that buried Pompeii and Herculaneum, the former being covered by fifteen feet, the latter by thirty or forty feet of *débris*, and which, at the same time, appears to have formed, by accumulation, the present mountain of Vesuvius, placed in the centre of the ancient circle, the work having been completed by innumerable successive eruptions.

The Vesuvius group is at present composed of two distinct mountains—namely, the cone of Vesuvius, and the rest of the ancient circle which form, to the north and west, a vast amphitheatre, named *La Somma*. Between the two mountains is an elevated horse-shoe-shaped valley, the middle part of which bears the name of *Atrio del Cavallo*, and the upper extremity, toward the east, that of *Canale del Inferno*. For a certain number of years, the centre of eruption of lava seems to have shifted toward Atrio del Cavallo.

In 1855 and the following years, eruptions made their way or had been thrown upon this point, and have transformed the elevated valley into a sort of sea of lava,

which at present may be about three fifths of a mile in breadth. The lava does not scoop out, but only rolls along the ground, the eroded ravines which furrow the sides of the mountain becoming necessarily their natural channels. Thus the successive currents have followed very nearly the same channel, being super-imposed on each other through a great part of their course. When the lava streams are of considerable depth, they often pass over small inequalities of ground, and leap to right and left when they strike against any considerable obstacle.

A good carriage-road leads from Resina as far as the Observatory, across the cultivated slopes, which are covered with houses. At less than a kilometre from the Observatory, the road traverses the lava of 1858, which has covered up the old route, and through which it has become necessary to re-open the way. Almost immediately after having passed the lava, the Observatory is reached, where Professor Palmieri sojourned during the terrible days of the last eruption. This building, situated at a height of six hundred metres, is a substantial free-stone structure of two stories, surrounded by beautiful terraces which overlook the lava field on all sides, and the edges of which are inclosed by a handsome railing not much in keeping with the desolate aspect of the place. M. Palmieri has been compelled, for the want of trained assistants, to set up registering apparatus, and can obtain certain connected observations only during the time of his occasional stay at the Observatory. But for this circumstance, the last eruption would probably have been foreseen for some time.

From the Observatory, the summit of Mount Vesuvius can be reached in two hours. The road skirts the immense fields of black lava which stretch between Monte Canteroni and the foot of Vesuvius, and which have been formed by the recent eruptions as they escaped from Atrio del Cavallo. The lava of April 26th M. de Saussure found already quite cooled on the surface. There would not appear to be a greater amount of incandescence at the bottom of any crevasse, although the matter certainly preserves its heat under the superficial stratum, as was attested by the great number of fumaroles encountered almost everywhere. These emanations escaped for the most part from little kilns, or swollen crevasses, which communicate by clefts with the deeper lava. Around some of these fires there prevailed a strong odor of hydrochloric acid, while other vents did not emit any thing but steam or warm air. These are, indeed, the successive

phases which mark these emanations of lava until they reach complete coolness.

At first, the whole surface of the lava-streams seems to exhale steam and hydrochloric acid, and the atmosphere is filled with a disagreeable odor which makes breathing uncomfortable. But very quickly the exhalations are localised around the little centres of fire, whose activity continues for many months, and emanations from which are gradually modified. Thus, as seen from Naples at the time of the visit, the whole of the lava appeared to be smoking, and it was possible clearly to distinguish the tracks of the whitish vapors which appeared to wander over the surface; but close at hand there was nothing to be seen but the fumaroles, between each of which there is plenty of space. The gas and the hot vapors which the lava emits are charged with numerous substances, and become the source of mineral deposits which fill the tourist with wonder. One of the most curious phenomena observed is the power of burning lava to retain an enormous quantity of water and salt, which it does not allow to escape until it begins to cool. The formation of salt is shown generally over the whole stretch of lava emitted in 1872. Soon after the surface cools it is covered with a light crust of salt, which forms in similar flowery patterns on the beds of cinders that cover the plains, the cinders themselves emitting everywhere hydrochloric acid. The first showers caused this deposit rapidly to disappear, and there remained on the 12th of May only scanty traces, except on the lower surface of the blocks, where the rain had not the power to dissolve it. But the salt continued to be deposited in the vents, from which were detached beautiful crystals and graceful concretions; it continued also to be formed upon the great deposits of cinders on the cone of Vesuvius, and, even on May 19th, the summit of the mountain, as seen from the Observatory, appeared from this cause as if sprinkled with snow.

Next to salt, the substance which is formed in greatest abundance upon the lava is chloride of iron, which assumes the most varied tints according to its surrounding, but is in general of a beautiful yellow, often orange, and is easily mistaken for sulphur. A multitude of other substances are deposited around the smoke-vents, besides those which have been named. These are for the most part metallic compounds, especially chlorides, and more rarely sulphur-compounds. There are chlorides of copper and lead, hæmatite and magnetic iron-ore, gypsum, etc. The peroxide of iron, in particular, plays an important part in the life of these fumaroles; it appears to be formed by

the decomposition of chloride of iron; the protuberances of the scoriæ are often covered with the substance, which gives them the richest and most brilliant variegated appearance.

The origin of these many substances has considerably occupied the attention of chemists, and has not yet been satisfactorily explained; but the form of the concretions, as much as the accumulation of substance, apparently foreign to lava, indicate that they are formed by sublimation.

When the summit of the cone was approached, fine ashes were found scattered about the transverse rents that are apt to be taken for ruptures caused by the concussions accompanying the eruptions. But violent fissures would rather have formed radiating or longitudinal rents, while these are perhaps only the effect of the settlement of the cinders which naturally tend to act in the direction of the greatest slope, and to give rise to fissures analogous to those which are observed in the centre of the Alps. It is to this same phenomenon that must be attributed the step-like structure, traces of which are met with on the external face of the summit of the mountain, and which is probably owing to the fact that the lower edge of the rents must be elevated by the settlement, while the upper edge remains unaffected, or is itself lowered in supplying the matter which afterward fills the rents. On the outside face of the cone, these steps are scarcely more than three or four inches in height, but on the margin of the internal face of the south-west side of the crater are four large sharp-edged steps of more than a metre high, arranged stair-wise, the formation of which can scarcely be explained otherwise than by a deposit or a flow of ashes accumulated at the end of the last eruption.

A vast transverse funnel, much larger than it is broad, occupies the south-west part of the summit of the cone, and this gulf is itself divided at the bottom by a partition of rocks which divides it into two compartments. A third crater occupies the north part, and is separated from the first by a considerable wall of rocks. This latter crater opens into the great north fissure which descends into Atrio del Cavallo; it was opened during the last eruption at the expense of an adventitious cone raised in 1855, and appears to have been the most active, since it is upon its side that the mountain is rent as far as the base of the cone; however, it has not ejected any lava, this having found its way out by the bottom of the fissure. During the eruption, the lava was raised as far as the summit of

the mountain—it has filled to the brim the double crater on the south-west—yet two days after this the lava had escaped by the south side; for on the 24th of April it overflowed the crater and formed three streams on the south, the west, and the north-east, which flowed down the slopes of the cone, and lost themselves among the fields of lava underneath. After this event the lava fell back to the bottom of the craters.

The depth of the crater may be estimated at about 400 feet. The bottom appears to be full of *débris* and ashes, but shows no sign of incandescence, nor of any adventitious cone; no smoke ascends, and the volcano, after its convulsion, has apparently fallen into a complete sleep. The only signs of activity are seen in the numerous unimportant jets of white vapor which escape either from the bottom or from various points in the walls, and which appear to dissolve in the atmosphere. Nevertheless, as seen from Naples, Vesuvius always appears with a light smoke hanging over it, which is invisible on the mountain itself. On the side next Pompeii only, to the east and north-east the slopes are macadamized by bomb-like blocks of the size of the head. The crater must have projected from all sides a shower of such blocks, but over all the other parts of the mountain this deposit must have been covered by a thick bed of ashes; and since these blocks are seen only on the east, it is evident that at the time of the last eruption of cinders a violent wind must have blown them to the opposite side. The large blocks, if they have been thrown up to the height of 4700 feet, appear to have fallen back at a short distance from the crater. Shot vertically, they fell so, while the ashes, on account of their greater lightness, have been carried to a greater distance.

The crater on the south-west is divided through and through by a narrow rent, which is doubtless the prolongation of that which on the 24th emitted, half way up, the lava which went in the direction of Torre del Greco. This rent divides the south crest, and may be traced upon the walls of the crater, where it looks only like a simple fissure; it re-appears more distinctly on the opposite side. Another disappears among the cracks of the rocks. This rent exhaled at the summit of the crater burning gases, which formed upon the sides abundant deposits. The south crest was sufficiently filled up by sand to enable one to cross it, but such a quantity of sulphurous vapors was emitted, that to escape being asphyxiated it was necessary to make several rapid leaps. On the west side

of the crater the rent still gapes, and has not been filled up, notwithstanding the heat which escaped.

The eruption of April 26th which followed the rending of Vesuvius, re-opening the same vent, suddenly made its way to the same point, shattering the manifold bed of lava, and ejecting to the surface immense blocks, probably torn from their beds far below. Of this *débris*, mixed with incandescent lava, there is formed an elongated ridge of about 160 feet high, from the base of which there sprung an enormous mass of lava that swept over the little cone of Atrio. The lava burst forth at first in all directions, even a little behind in ascending the valley. It filled all Atrio, without, however, incrusting anywhere the sides of the rocks of the Amphitheatre of La Somma, and flowed along the valley in the form of a current of about three fifths of a mile broad. Subsequently encountering the ridge of Canteroni, it was turned to the right, though a part of it was separated by the upper extremity of this knoll, and diverted to the left on to the slopes of Piano, where it contorted somewhat the foot of the mountain, thanks to the lava of 1858, which, having changed the slope of the ground, prevented it from continuing its route. The principal stream continued to follow the valley of the Fosso de la Ventrana, running at the rate of about one mile in two hours, passing under the Observatory, where the lava was seen to boil up at places and shoot forth into little eruptions, projecting jets of steam and scoriæ; then it was precipitated in a cascade of fire, over a wall of rock, and continued its course by the same ravine as the stream of 1855, and for the greater part of its course overrunning the lava of that year. It passed exactly as its predecessor did, between the villages of Massa and San Sebastiano, sweeping away likewise a portion of the houses, part of it at last lodging itself on the south of Cercola, while a branch of the current continued in the direction of San Giorgio.

The imagination is unable to comprehend how such a mass of matter could escape in a single day from a single fire, and spread itself over an area of seven kilometres, or over four miles. The elongated ridge formed in the Atrio, at the time of the eruption, upon the site of the centre of the outbreak, appears at present only like a huge bubble on the sea of lava. It is composed of recent black lava, strewed with enormous blocks of old bleached lava encased in the new. These blocks are, without doubt, the *débris* of subjacent beds which have been broken and driven back by the lava at the time of its outbreak; the mass of them encrusted with the same lava

having formed a whole so solid that it could not be swept away by the general current. This ridge does not now overtop the surface of the lava more than forty-five to sixty feet, from which we may conclude that the bed of lava at this point has an enormous depth.

An examination of the lava of 1872 does not appear likely to lead to any new results. Its mineralogical nature is essentially the same as that of the other lavas of all ages that have been found both on Vesuvius and in La Somma. It is composed of a leucitic rock strewn with crystals of augite, and destitute of vitreous felspar; whence the names of leucitiferous or augitiferous, as one or other substance prevails. The most ancient lava which forms the body and crevices of La Somma, is in general very pale; it often contains an abundance of leucite crystals, of the size of a foot; but its composition is, qualitatively, essentially analogous to that of the actual black lava. The lava of 1872 differs considerably in its physical appearance from that of 1858. The last is much less scoriated; it has a fleecy surface formed of round embossments, shining and comparatively little roughened. We might liken it to black whipped cream, which has flowed along, forming arches, fibrous stalactites, twisted cords, which look at places as if vitrified. The lava of 1872, on the contrary, is extremely scoriaceous, and assumes a form almost like madrepore. On account of the great shrinking of the material, it has been broken up into blocks, entirely separated from each other, and roundish, because the mass was as yet vitreous; porous, in consequence of the quantity of gas it inclosed, and full of the most curious irregularities resembling coral and vegetation, which render progress infinitely difficult. The difference of appearance, combined with a thin layer of gray cinders which adheres to the lava of 1872, enables one to distinguish at once between it and those of preceding years. It will be noticed also to the north of the Observatory that the current has filled all the bottom of the valley of Ventrana, while on the south it has only run into the crevices of the old lava, surrounding the knolls, separating, re-uniting, leaving here and there inlets, as rivers without any determinate bed do at low water. This difference of structure of the two lavas seems to result from the very rapid cooling of that of 1872.

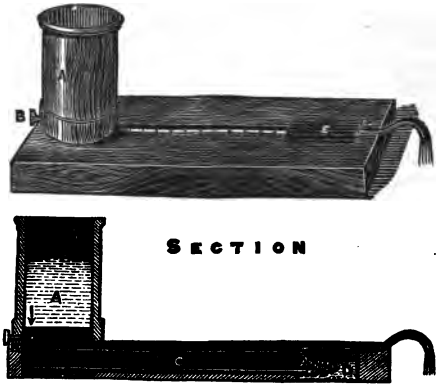
It is not easy to form a notion of the depth of this lava. In the lower parts the bed is about eight metres deep, with a breadth of about 800 metres; its borders form moraines of 45°, which indicate the small fluidity of the

matter at the time it reached the place. In Atrio del Cavallo the moraine of the bed of lava which leans against the foot of the rocks of La Somma is less elevated, but the enormous waves in the middle of this surface argue in some places a considerable thickness.

The successive eruptions which have taken place in Atrio and which have piled up layer on layer, have enormously raised the level of the ground. A German geologist has conceived the idea of counting the layers which form the vertical dykes on the rocks of La Somma. At present the number would be hidden beneath more than a hundred feet of lava.

A NEW HYGROMETER.

By George Dines.—For using this instrument water only of a lower temperature than the dew-point is required; in summer, well-water will generally be found sufficiently cold; but if not, ice is recommended as the simplest means of cooling the water. In severe frost, when ice is always to be obtained, salt mixed with the ice will generally give a temperature sufficiently low for the purposes required. The water is placed in the vessel A; the tap B is opened, which allows the water from A to flow through the chamber D, and to



cool the thin black glass E with which that chamber is covered. As soon as the dew appears upon the surface of the glass the tap B is turned off, thus preventing any further flow of the water, and the attached thermometer, the bulb of which is placed inside D, close under the sur-

face of the glass, gives the temperature of the dew-point. Before deciding upon the use of black glass as a cover to D, I had tried most of the metals.

THE UPHAM COLLECTION OF METEORITES AND SIMILAR TERRESTRIAL MINERALS.

PROBABLY the largest collection of meteoric specimens, stones and irons, in this country, is that belonging to Professor Charles Upham Shepard, of Amherst College, Mass., and now deposited in that institution. The whole number of specimens exceeds five hundred. The catalogue gives the locality, date, and hour of fall, begins with the specimen of the meteoric stone which fell Nov. 7th, 1492, in Alsace, France, and extends to May 21st, 1871. We believe that other specimens have since been added. All parts of the globe have furnished contributions to this rare collection of the meteoric irons. The aeriotopos specimen, from Bear Creek, Colorado, which fell in 1863, is the heaviest, and weighs 438 pounds. The heaviest stone is that from New-Concord, Ohio, weight 52 pounds, fell May 1st, 1860. Professor Shepard states that, "supplementary to the meteorites is a collection of several hundred specimens, derived from an extensive geological formation of a bronzitic character, situated in the immediate vicinity of Havana, (W. I.) Each of these specimens is a distinct nodule, whose shape and external configuration are such as to render its distinction from a true meteoric stone difficult, except perhaps by its color. Although they were collected almost indiscriminately from a quarried heap of about forty tons of the formation, they nevertheless illustrate the relative sizes as well as shapes of an equal number of meteoric stones, as found in our largest cabinets. The largest specimen weighs over seventy pounds, the smallest less than fifty grains. In general shape they are cubical, with a tendency to pyramidal, and occasionally to the spherical and obtusely conical,—the edges and angles being rounded, and the surfaces variously indented, precisely after the manner of most meteorites. They are smooth throughout, and even polished. They have either a green color (of several shades, generally pale) or are ash-gray. In rare instances, they are partly enfilmed with a shining pellicle of magnetite which makes the resemblance to certain meteoric stones very perfect.

"When broken, they are found to consist of at least three distinct minerals, though the three are never found

together in the same nodule. One variety is almost wholly made up of a light yellowish serpentine, somewhat analogous to the snarum pseudomorphs. This variety is often traversed by a network of thin seams of a darker variety, strikingly like those found in several rather compact meteoric stones. A second variety consists of a hydrated bronzite, which is both massive and crystalline,—in the latter state presenting minute coppery laminæ, with the characteristic fibrous cleavage.

"The third variety of these stones, and which is rare, consists of a blackish leek-green serpentine, possessed of the oily lustre belonging to the freshest specimens of this species. It is chiefly remarkable for containing very minute six-sided scales of a golden yellow marcasite, rich in nickel. Besides the presence of chromium, traces of phosphoric acid are present.

"The mineral containing these nodules is altogether peculiar in its physical properties, although possessing a composition not differing essentially from serpentine. It is nearly as fragile as deweylite, which it somewhat resembles, though having a sub-laminated structure,—the layers being thin, curved, and much interlaced.

"On surveying the composition of these nodules, and their envelopes, it will readily appear that they contain the elements of the average litholites; and if we make exception of the water, and at the same time allow for the reduction of the magnetite which is everywhere present, more or less mixed with chromite, the proportions of the constituents will be found scarcely at all inconsistent with those of most meteoric stones. This circumstance, taken with the fact that the nodules simulate so exactly the size and shape as well as quality of surface belonging to meteoric stones, (whose configuration has hitherto been an unsolved enigma,) may possibly justify the hypothesis that meteorites have originated in the disruption of an asteroid, composed in part similarly to this bronzitic formation in Cuba, whose fragments in their orbital path have encountered an atmosphere of heated hydrogen, like that which the spectroscope has revealed in the outer envelope of our sun, as well as that forming the luminous portions of comets. The discovery by Graham of hydrogen in a state of alloy with the metallic portions of meteorites, is certainly favorable to such an hypothesis.

"The fragments of a disrupted asteroid would of course continue in general to pursue the track of the original body. In process of time, however, from the disturbing attraction of the sun, and from the retardation of resisting media, they would become distributed into groups accord-

ing to the density of the fragments; and whenever the earth by its proximity to the meteoric tract should draw to its surface portions of the revolving stream, we should expect such portions to possess, for each particular fall, an uniform specific gravity, and, growing out of this, a close resemblance also in general properties. Such has ever been a fact, and one for which no reason has hitherto been assigned.

"Whoever has examined meteoric stones under the microscope has recognized a molecular arrangement wholly peculiar, as compared with that of terrestrial minerals, or the artificial products of the laboratory. May not this structure result from the transformation, by heated hydrogen, of compounds like those above described?

"Instead of considering this anomalous conglomerate of pseudo crystals and balls in pyroidesine as originating in the hydration and metamorphosis of chrysolite, amphibolite, augite, etc., it would equally be impossible to explain it by an analogous change taking place in a vast deposit of meteoric matter. It is, however, more reasonable to regard it as belonging to our intrusive plutonic series of rocks; and as representing those more deeply seated layers of the earth's crust, the nature of which we have so many reasons for supposing to be similar to the meteorites." (21)

METEOROLOGICAL TELEGRAPH.

STEPHEN CHESTER has suggested a series of ingenious and practical instruments intended to automatically telegraph to a distant station, through a single wire, the direction and velocity of the wind, the range of the barometer and thermometer, and such other meteorological conditions as it may be desirable to notice.

The first, or "direction-of-wind" instrument consists of a vane which, as it moves with the wind, carries with it a spring that bears on two insulated metallic rings, one of which is divided into segments, each of said segments being duly insulated, provided with a conducting-wire, and connected with a different cup of a voltaic battery. The solid ring has a wire, also, which connects the instrument with another yet to be described, and the spring above mentioned forms a metallic connection between the solid ring and that segment on which the spring rests, which, of course, varies with the position of the vane as it is changed by the wind. The sections of the divided ring are so connected with the cups of the voltaic battery

that, if the spring rests on cup No. 1, only that cup is in the circuit; if on No. 2, two cups are in it; and if on No. 10, ten cups; so that if the wire from the solid ring be connected with a galvanometer at a distant station, the attendant there will be able to judge from the deflection of that instrument how many cups are in the circuit, and from that on which of the segments the spring rests, and consequently the direction in which the wind is blowing.

The instrument for indicating the wind's velocity consists of a wind-mill, having on its shaft a small projection, which at every revolution touches two springs, and thus completes a circuit of which these springs form a part, and the opening and closing of this circuit operates at the distant station an instrument similar to a Morse register, through which a strip of paper is passing at a graduated rate. If the wind-mill is revolving fast, the circuit is opened and closed rapidly, and the marker of the register dots the paper with corresponding speed, so that the rate at which the mill revolves and the velocity of wind can be correctly ascertained by inspecting the paper.

The barometer and thermometer each have wires connected with the mercury in their bowls and a series of wires (each of which is connected with a cup of a battery,) passing through the sides of their respective tubes. The higher the mercury rises the more wires will be touched by it, the more cups will be thrown into the circuit, and the greater the effect on the galvanometer at the distant station.

To combine these instruments so that all will work on one wire, without interfering with each other, requires current-changers, one of which should be at each station. The current-changer consists of a train of clock-work, giving motion to a "switch-wheel," revolving at a graduated speed—say once in five minutes. Surrounding this wheel are as many pairs of springs as there are indicating instruments, one spring of each pair being in connection with one wire, and each of the other springs are connected by wires to different instruments. The "switch-wheel" has a portion of its periphery projecting, so as to touch each pair of springs in turn during its revolution, and while so touching a pair it completes the circuit between the line-wire and the instrument to which one of the springs of the pair is attached. As the switch-wheel revolves, it therefore throws into the circuit each instrument in turn, which is thereby enabled to transmit its indications to the distant station without interference with the other apparatus. At the receiving station a similar

"switch-wheel" may be employed to transfer the currents to the different registers or galvanometers.

In addition to this series of instruments, other forms of meteorological indicating and registering apparatus have been devised by the same gentleman.

DUST FROM VESUVIUS.

GEORGE GLADSTONE, F.C.S., states that during the eruption of Vesuvius which took place last spring, Naples and the surrounding country was visited by a shower of fine black dust. In some places the fall was very heavy, and even in Ischia, at twenty-five miles distance from the mountain, where the dust examined was collected, the quantity was sufficient to cause great annoyance to the inhabitants. It consisted of aggregations of crystallized quartz, dotted over with the magnetic oxide of iron. This ferroso-ferric oxide was also crystalline, and possessed a high metallic lustre. The grains were very uniform in size, and would pass through a wire-gauge the apertures of which measured the 16,000th part of a square inch.

EARTHLIGHT ON THE MOON.

PROF. SHALER, of Harvard, finds that with the 15-inch Mertz of the university observatory it is possible to see all the principal features of the topography of the dark region illuminated only with this earthshine. The eye is unable to recognise the craters by light and shade, the light being too feeble, besides being too vertical; the relief is due to the difference in the light-reflecting power of the various features of the topography. Whatever becomes very brilliant under the vertical iliumination of the full moon, shines out with a singular distinctness when lit by our earth's light. When the moon is not over twenty-four hours old, she is at her best for observation. The author was able to recognize nearly all the craters of the darkened part that are over fifteen miles in diameter, and probably one-half the bands which show with a power of 100 when the moon is full.

A NEW THEORY OF VOLCANOES.

BY ROBERT MALLET, F. R. S.—The contraction of our globe from the period of its original fluidity to its present state, has produced various deformations of the spheroid, forming firstly the ocean basins and the land; afterwards, by foldings over and elevations of the thickened crust, mountain ranges; in our day the continuous contraction is manifested by its giving rise to volcanic action.

The theory of mountain elevation proposed by C.

Prevost ascribes this to tangential pressures, propagated through a crust of sufficient thickness to transmit them, those pressures being produced by the relative rate of contraction of the nucleus and the crust; the former being at the higher temperature, and having a higher co-efficient of contraction for equal loss of heat, tends to shrink from beneath the crust, leaving the latter partially unsupported. This, which during a much more rapid rate of cooling gave rise in former epochs to mountain elevation, in the present state of things gives rise to volcanic heat.

The earth's solid crust, however great may be its thickness, and even if of materials far more cohesive and rigid than those of which we must suppose it to consist, must, if even to a very small extent left unsupported by the shrinking away of the nucleus, crush up in places by its own gravity and by the attraction of the nucleus.

This is actually going on, and in this partial crushing, at places or depths dependent on the materials, we find the true cause of volcanic heat.

As the solid crust sinks together to follow down after the shrinking nucleus, the *work* expended in mutual crushing and dislocation of its parts is *transformed into heat*, by which, at the places when the crushing sufficiently takes place, the material of the rock so crushed and of that adjacent to it are heated even to fusion. The access of water to such points determines volcanic eruption. Volcanic heat, therefore, is one result of the secular cooling of a terraqueous globe subject to gravitation.

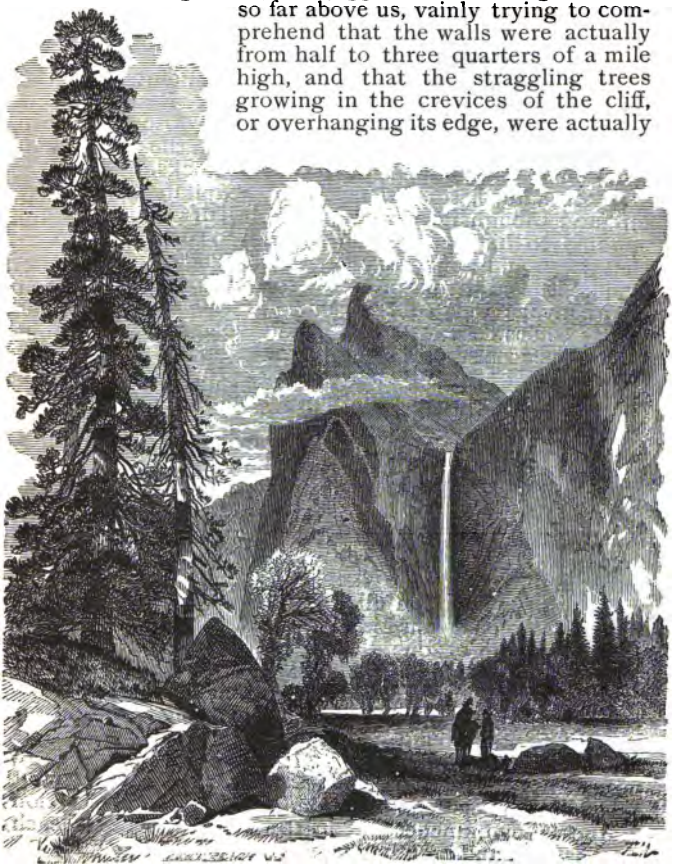
To test the validity of this, two series of experiments, conducted on a large scale, were made: the one on the actual amount of heat capable of being developed by the crushing of sixteen different species of rocks, chosen so as to be representative of the whole series of known rock formations, from oolites down to the hardest crystalline rocks; the other, as the co-efficient of total contraction between fusion and solidification at the existing mean temperature of the atmosphere, of pasic and acid slags analogous to melted rocks.

By the aid of dates thus obtained, the theory, when compared with such facts as we at present possess, as to the present rate of cooling of our globe, and the total amount of volcanic action taking place upon its surface and within its crust, shows, that by estimates which allow an ample margin to the best dates we possess as to the annual vulcanicity of our globe at present, that less than one fourth of the total heat at present annually lost by

our globe is sufficient to account for it. The secular cooling, small as it is, now going on, is a sufficient *primum mobile*, leaving the greater portion still to be dissipated by radiation.

THE YOSEMITE VALLEY.

By J. H. Bromley, Scribner's Magazine.—With busy eyes intent on all the wonders round us, but turning oftenest to range along the jagged rim and fringe of trees so far above us, vainly trying to comprehend that the walls were actually from half to three quarters of a mile high, and that the straggling trees growing in the crevices of the cliff, or overhanging its edge, were actually

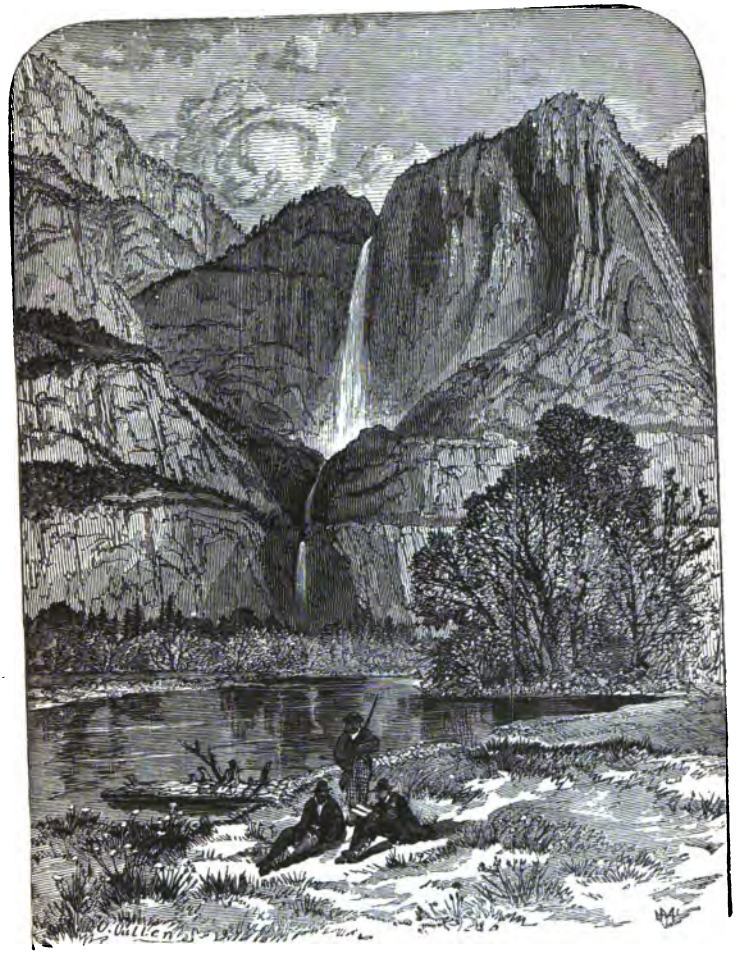


BRIDAL VAIL FALL.

trees one hundred and fifty feet in height, and not the scrubby bushes they look to be—we walked our horses slowly along through the openings and among the trees, across the dry bed where, in spring, the mountain torrent had torn its way along, leaving in its wake the great bowlders and rocky masses it had wrenched from their foundations, and fording the small stream that issued from the Bridal Vail, came up into a full view of the fall. The trees that intervened hid from sight the slope of rocks and débris down which the stream bounds its last three hundred feet, so that to our eyes it seemed a single fall of the whole nine hundred feet.

What had appeared from Inspiration Point to be the merest ribbon fluttering down the rock, we found was a considerable volume of water, and we forded it as we wound our way along and passed through the narrow gap between El Capitan and the Cathedral Rocks. The great weather-stained, scarred face of El Capitan was on our left, and though its base was almost half a mile away, it towered so high above and seemed so to hang over us, that we should almost have said we could throw a stone against it from the path. No picture by pen or brush can ever convey an idea of the vastness of this view; its magnitude baffles description; nor can the spectator begin to realize it except after seeing it from all points, and studying for days at a time its colossal features in detail.

Just back of the hotel the Sentinel Summit towered three thousand feet above us, the topmost thousand feet an obelisk, from which the rock takes its name; at our left, as we sat on the porch, the view began with the white cliff, El Capitan; then came the Three Brothers, or Leaping Frogs; directly in front was the great Yosemite Fall, with its magnificent leap of two thousand six hundred feet from the lip to the level of the valley, and away under at our right were the Domes; with the mountain walls connecting them all. The best distant view of the Yosemite Fall is from Liedig's porch. It is a double fall; the upper one of one thousand five hundred feet, the lower of four hundred, with a descent of over six hundred between the two. The shelf on which it first drops has the appearance, from the porch, of being about broad enough to step round on comfortably without danger of falling over the lower edge. It is, in fact, a third of a mile wide, and not less than fifteen acres in extent. About two miles up beyond the Yosemite Fall, the main portion of the valley branches out in three narrow canons, each one distinct, and each having its own special attractions.



THE YOSEMITE FALL

METEOROLOGY OF THE BOSTON FIRE.

MR. H. E. COLE, U. S. signal officer, reports the following observations made during the progress of the great conflagration in Boston, Oct., 1872. The wind at this station during the progress of the fire varied from north-north-west to north, with a velocity of from five to nine miles per hour, weather being clear, cool, and pleasant. On approaching the fire on the north or windward side, as close as the heat would allow, the indraught of air through the burning streets assumed the character of a brisk wind, probably sixteen or eighteen miles per hour, while the heat was so intense as to cause smoke, steam, etc., to be carried up in spirals to a great elevation. On the south or lee side, the induced currents of air were very strong, probably thirty or thirty-five miles per hour, carrying the fire bodily to windward. This state of affairs appears to be the reverse of the Chicago fire in 1871, where the strength of the wind was sufficient to overcome the induced currents and the fire burned to leeward. It appears as if the high wind permitted the indraught to rise at a considerable angle after reaching the fire, leaving a large space of highly rarefied air in its front, inducing stronger currents to flow in, which, meeting the indraught, gave the spiral or whirlwind form to the ascending current.

During the fire, a flock of ducks passed at a great height overhead, and the light reflected from their plumage made them appear as fire-balls passing rapidly through the air. Many who saw them called them meteors, and likened them to the balls of fire said to have been seen in the North-west during the great fires in that region. As an example of the great heat diffused, I would state that during the night I exposed a thermometer in the observatory to the full glare of the fire, when it rose nearly five degrees, although placed upward of two thousand feet from the burning district and dead to windward of it. The barometer rose slightly and the weather remained unchanged.

PREVENTING THE SPREAD OF FIRES.

As a means of preventing fires from spreading from house to house, W. D. Baker proposes that a double metal partition be interposed between adjoining houses, and the space therein be filled with water from the street mains in case of fire. The top of the partition may be open, or it may be perforated with small holes, and water forced in the space would run out in the form of spray, and serve to extinguish the fire in one house, and keep the roof of the other from igniting by flying sparks.

THE BRITISH EXPLORING EXPEDITION.

THE preparations for the English circumnavigating exploring expedition give promise of results of great value to both science and civilization. The vessel set apart for the purpose is H. M. S. Challenger, a main-deck corvette of two thousand three hundred tons. Her commander is Captain G. S. Nares, well known as the author of a valuable work on seamanship. Second in command is Commander J. P. Maclean, son of the late astronomer royal at the Cape of Good Hope, who will have charge of the magnetic observations which will form part of the work of the expedition. The Challenger has been put in thorough repair, and specially fitted out for the occasion. Stages have been erected amidships, from which the dredges will be worked; and immediately aft of these is the steam winding-in apparatus. A chemical laboratory and naturalist's work-room have been fitted up in the after-part of the vessel; and the fore-magazine is set aside for the storage of the large quantities of spirits required for the preservation of natural-history specimens, and of the many thousand stoppered bottles which will contain them. Among the stores are traps of various forms, harpoons, a harpoon-gun, and fishing-tackle of all kinds, including trawls, trammels, a seine, shrimp-nets, fish-traps, and lobster-pots. From the latter, used in deep water, great results are expected; and it is not improbable that living specimens of nautilus may thus be procured. The scientific staff, under the direction of Professor Wyville Thomson, numbers five able and experienced scientists. The route to be followed by the Challenger, though not yet fully determined, will be nearly as follows: Leaving Portsmouth about the middle of November, she will sail for Gibraltar, the first haul of the dredge being made in the Bay of Biscay. From Gibraltar she will proceed to Madeira; thence to St. Thomas, the Bahamas, Bermuda, and the Azores; thence to Bahia, touching at Fernando de Noronha; then across to the Cape of Good Hope; thence southward to the Croset and Marion Islands, continuing in this course until ice is reached. Australia, New-Zealand, the Campbell and Auckland Groups, Torres Straits, New-Guinea, and New-Ireland, will then be visited. A year will be spent among the Pacific islands; Japan, Kamtchatka, and the regions further north, thoroughly explored; the return being made by the way of Cape Horn. The voyage is expected to take about three years and a half, as the deep-sea work—the main object of the expedition—is to be supplemented by that of a general inland exploration, with accurate investigations of many of those distant and almost unknown islands of the sea. (70)

GEOLOGY AND MINERALOGY.

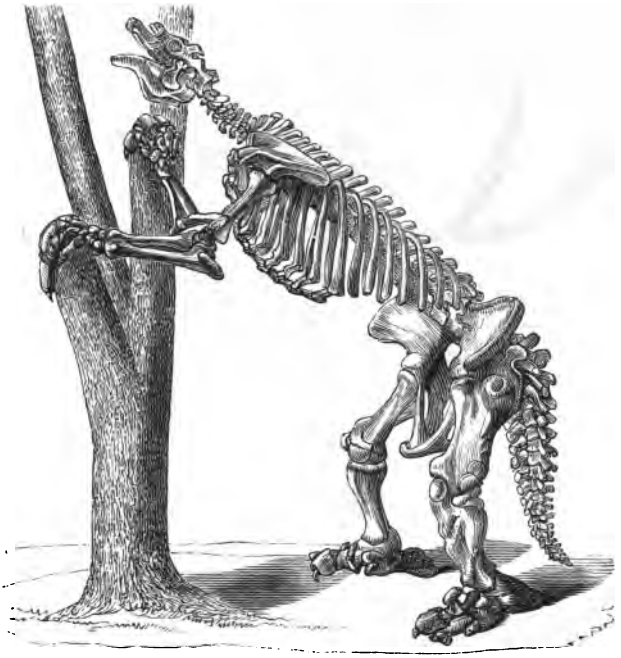
STRANGE ANIMALS FROM GEOLOGICAL TIMES.

LONG before Darwin propounded his development theory, it was acknowledged that the structure of the different animals constituted a series of forms, connected together like chains, of which every link differed only slightly from the preceding, and that by the accumulation of such differences in certain definite directions, the most varied forms were produced. The investigations of geology, or rather of that newer science, the outgrowth of

PTERODACTYLUS SPECTABILIS, OR WING-FINGERED ANIMAL.

geology, named paleontology, which studies the forms and relations of extinct animals from their petrified remains, has filled up many missing links in this chain, and has shown how in different animals the same plan of structure, by certain modifications of the parts, was made to perform quite various functions.

This fact is, by the way, one of the points in Darwin's hypothesis, which is based on the fact that the circumstances in which the animal is placed may greatly alter the details in its structure. The experience of man in domesticating animals affirms this; only Darwin goes so far as to assert that finally, by the accumulation of such influences, entirely new species may be developed; nay, even that all the existing species have been formed from pre-



THE MEGATHERIUM.

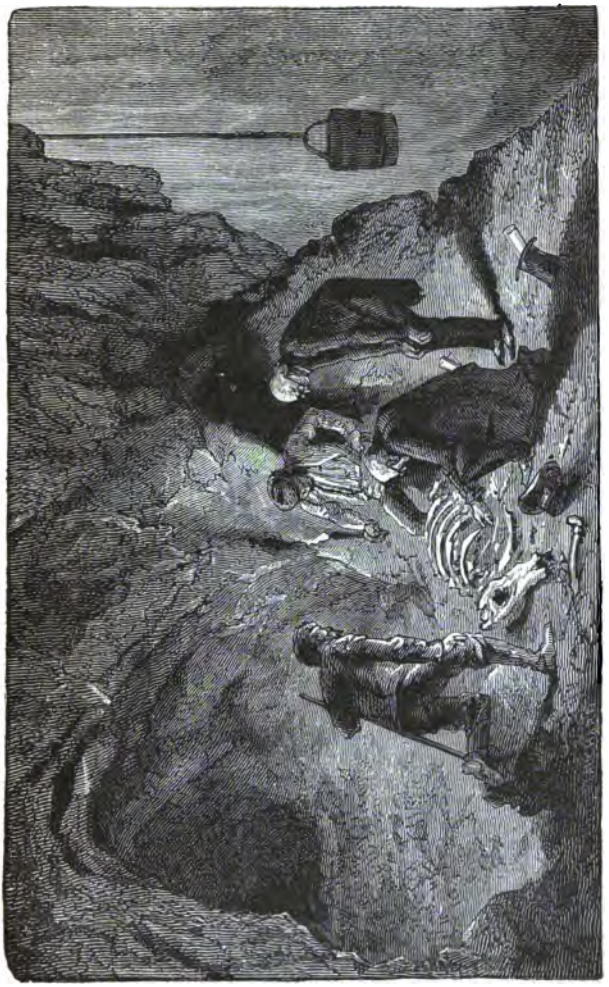
ceding simpler ones, after such a law. In this latter assertion the majority of naturalists have not yet concluded to agree. Agassiz is one of the most prominent opponents of this doctrine, which must not be understood as reasoning away divine agency in the creation of the universe; but only attempts to explain how the Creator may have produced the different animal species after a certain preordained law of gradual development.

Among some of the most curious fossil remains illustrating some of the points mentioned is the pterodactylus, meaning the wing-fingered animal represented in our engraving. The four legs show the quadruped; but the skull, with the long beak, shows a similarity with an aqueous bird; the teeth, however, found most perfect in many specimens, show the true nature of the animal. The position of neck and head again remind of the bird, while, however, there can have been no question of feathers. The fingers, so largely developed in length, and the front legs, indicate evidently that a membrane extended between

THE MASTODON.

them, serving as wings, as is the case with the bat; probably also connected with the hind legs, which are attached to a diminutive and almost atrophied pelvis, for which this animal had no use, as the hind legs were not used for walking, all locomotion being only accomplished by flying; while the animal rested by suspending itself from the hooks of its fingers. Attention ought to be also called to the fact that all the bones of arm and hand and fingers are there, only modified in size, especially the bones of the little finger.

The contrast of this animal with the megatherium, represented in our second engraving, is very striking.



BONE CAVERN, MAESTRICHT, HOLLAND.

Here we have one of the most slowly moving quadrupeds, a gigantic sloth, which, unlike that of the present day, by reason of its weight could not climb a tree; the pelvis and hind leg are developed to an enormous size, having to carry so heavy a weight, while even the tail, judging from its size and strength, served also for incidental support. The animal was 8 feet high when stooping on four legs; but when in the position here represented, could easily reach a height of 20 to 30 feet, as its body alone was over 20 feet long. It has the most colossal hind legs of all animals, while the front legs were attached in a rotary socket, as in man, which, in combination with its prehensile fingers, shows that the animal used its hands like a monkey, to pluck its food and bring it to the mouth. A curious fact is, that specimens of this genus have been found with a cracked skull, which Owen explains by suggesting that, as the animal could not climb the tall trees, on the leaves of which it fed, it brought the trees down by using its powerful teeth to gnaw the trunks through, and on such occasions the animal was of course in imminent danger of being killed by the falling tree.

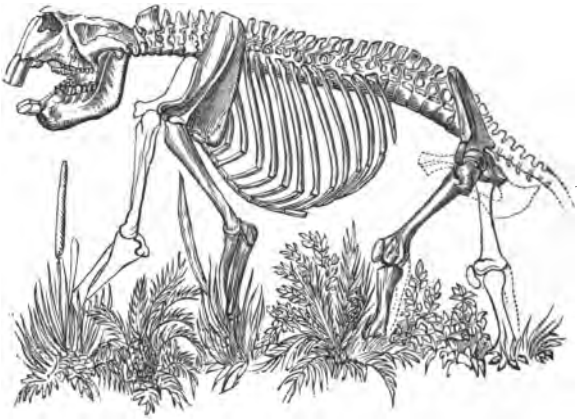
The megatherium here represented is found in South America; also in the northern part of our continent. The skeleton of one may be seen in the museum of Boston.

The peculiarities in the details of many fossil remains make it almost certain that our present animals are their descendants, and that the differences are solely due to exterior influences, which first modified their development, and then caused those races which were not so well adapted to the new circumstances to become extinct; while those more adapted, continued to live and transmit their favorable peculiarities to their descendants. The mastodon is an illustration of this sort. Our figure represents the skeleton of this animal as found in the diluvium at Cohoes, N.Y., and now preserved in the State geological collection at Albany. He was undoubtedly the progenitor of the modern elephant, and, unlike most other quadrupeds, he stands, like the elephant, on the tips of all his five fingers and toes.

It is well known that Australia is peopled with a peculiar class of quadrupeds not found elsewhere, the marsupials of which the well-known kangaroo is a type. Singularly enough, the fossil fauna of that remote and isolated region proves that this was the case also in geological periods, and that this continent possessed once the most colossal animals of that class. One of them is the dipro-

todon, of which the skull alone was three feet long; his teeth resemble those of the megatherium, but are much more powerful; with his very prominent incisors this animal was enabled to cut heavy trunks, and bring large trees down, in order to devour their foliage, on which this class of animals live.

New-Zealand is geographically united to Australia, but its fauna and flora are totally different; and the geological investigations thus far made show that this has



THE DIPROTODON.

been so always. The size of its birds has been enormously decreased. During the diluvial period, that country possessed at least a dozen different races of colossal birds, subdivided into many species, and of which the largest even did surpass in size the modern ostrich and cassowary. Now all the birds are very small and shy, and are rapidly being exterminated. Among the fossil skeletons, there is one which was a real giant among the birds. It is called the moa; and if the tradition of the natives can be believed, this bird did still exist with their ancestors, and has only been extinct for a very few centuries.

PREHISTORIC MUSEUM.

THE interesting collection of ethnology and prehistoric remains bequeathed by the late Mr. Henry Christie, are now arranged in the museum, 103 Victoria Street, Westminster, London, admission to which is by ticket available only on Fridays, from ten to four. The tickets are

obtained at the British Museum itself, on any of the d
days, on application. The collection (in four rooms) c
tains prehistoric remains of Europe, Asia, and Af
The flint implements from the drift are here most be
fully and symmetrically arranged, and you can obse
even from that period, the advance from the rudely-chi
celt to its more polished successor. Daggers, sp
heads, saws, arrow-heads, besides celts, chisels,
gouges, are here all represented. Some from Sa
Downham, Norfolk, from Hoxne, Suffolk, the York
wolds, the Irish celt, ax, and hammer-heads, etc., of
own peculiar type. Most interesting, too, are the rem
from the caves of Dordogne, France, consisting chie
the animal remains of the mammoth, hyena, reindeer,
horse, some of the bones of the former having the figu
the animal itself engraved on them; of flint and wo
bone implements, arrow-heads and scrapers, barbed s
heads for fishing, and ornaments of fossil shells, with
dles from the shank-bones of the horse. These for
most valuable part of the collection. In contrast
them is the ethnographical collection, (modern races
notably in this are the Esquimaux, exhibiting, i
chipped arrow-heads, and scrapers of silicious mat
harpoon-heads, and bone needles, their identity with
prehistoric prototypes. Of special interest are the ob
from ancient Mexico, sculpture, pottery of different k
arrow-heads, etc., the most remarkable among which
a mask formed out of a human skull, coated entirely
a mosaic-work of turquoise and obsidian. The eye
made of iron pyrites, very highly polished, so as to re
ble small convex mirrors; the teeth of a white stone
mouth being made to open; the mask is furnished
straps, so as to be worn. Here are, also, ancient ear
pipes in the form of animals, from the mounds of
North-America, which bring to mind the buried citi
the northern continent, a subject long the wonder o
historic student. In these divisions the ethnologist
study the manners, customs, and dress of the diffe
races of man, shown in their war implements, article
dress and domestic use, their musical instruments, etc.,
through tribes from the north-west coast of America, the
Asiatic Islands, China, Japan, North and Central Africa.
the Polynesian group, all exhibiting the characteristics
of the various races. To be brought face to face with the
remnants of a vast antiquity, excites in the mind of the
spectator a deep and thrilling interest, as he sees in these
rude emergencies of almost primitive man the gradual de-
velopment into higher and still higher types of civilization.

THE GREAT HOT SPRINGS AT GARDINER'S RIVER.

THE YELLOWSTONE REGION.

BY F. V. HAYDEN.—We take as our starting-point Fort Ellis, a beautiful frontier military post, located near the head of the fertile valley of the Gallatin. We commenced our winding way over the grassy hills that form the divide between the waters of the Missouri and the Yellowstone. Our course was nearly due east for about thirty miles, when we came to the valley of the Yellowstone, and then we ascended the valley for ten miles further, and pitched our permanent camp near Boteler's Ranch, close to the lower cañon. Here began the more difficult part of our journey. The whole party were filled with enthusiasm to catch a glimpse of the wonderful vision of which we had already heard so much. Opposite our camp were the Yellowstone Mountains, with peaks rising 12,000 feet above the sea-level and

6000 feet above the valley. For beauty and symmetry of outline I have never seen this range equaled in the Far West, and several members of the party, who were familiar with the mountains of Central Europe, were struck at once with the resemblance to the Alps. But we will continue our way up the valley, leaving behind us the lofty volcanic hills which wall us in on each side, and enter the lower cañon. Here granite walls rise on either side to the height of a thousand feet or more, and through the narrow gorge the river dashes with great velocity. The bright green color of the water, and the numerous ripples, capped with white foam, as the roaring torrent rushes around and over the multitude of rocks that have fallen from above into the channel, give a most picturesque view to the eye as we look from our lofty heights. Not the least attractive feature, and one that to us amounted to a wonder, was the abundance of fine trout which the river afforded. There seemed to be no limit to them, and hundreds of pounds' weight of the speckled beauties were caught by the different members of our party. But we can not linger here, although the scenery is very attractive, so we hasten on to the Devil's Slide, or Cinnabar Mountain, as it is usually called. It is one of the singular freaks of nature which occur very seldom in the West; is formed of alternate beds of sandstone, limestone, and quartzites, elevated to a nearly vertical position by those internal forces which acted in ages past to lift the mountain ranges into their present heights. As we stand at the base and look up the sides of the mountains, we are filled with wonder at the apparent evidences of the convulsions of nature which could have thrown 3000 to 5000 feet in thickness of rocks into their present position. Ridge after ridge extends down the steep sides of the mountain like lofty walls, the intervening softer portions having been washed away, leaving the harder layers projecting far above. At one locality the rocks incline in every possible direction, and are crushed together in the utmost confusion. Between the walls at one point is a band of bright brick-red clay, which has been mistaken for cinnabar, and hence the name of the mountain. The most conspicuous ridge is composed of basalt, and the igneous material was poured out on the surface when all the rocks were in a horizontal position during the Jurassic period. Indeed, all the rocks are either of the Carboniferous, Jurassic, or Cretaceous age. During the day we passed many examples of volcanic action, which in any other region would have excited attention. Small lakes, covered with wild fowl and fringed with a luxuriant growth of vegetation,

occupied the old volcanic craters. On the evening of the third day, as we came to the junction of Gardiner's River, the warm springs began to appear near the edge of the stream. The white calcareous deposit, which always indicates that those springs do exist, or have existed, covered the bottom, and from underneath this crust a stream poured a volume of water into the river, six feet wide and two feet deep, with a temperature of 130°. A little further up the stream were a number of hot springs of about the same temperature, with nearly circular basins six to ten feet in diameter and two to four feet deep. Around them had already gathered a number of invalids, who were living in tents, and their praises were enthusiastic in favor of the sanitary effects of the springs. Some of them were used for drinking and others for bathing purposes.

From the river our path led up the steep sides of the hill for about one mile, when we came suddenly and unexpectedly in full view of the springs. This wonder alone, our whole company agreed, surpassed all the descriptions which had been given by former travelers. Before us rose a high white mountain, looking precisely like a frozen cascade. It is formed by the calcareous sediment of the hot springs precipitated from the water as it flows down the steep declivities of the mountain-side. The upper portion is about one thousand feet above the waters of the Gardiner's River. The surface covered with the deposit comprises from three to four square miles. The springs now in active operation cover an area of about one square mile, while the rest of the territory is occupied by the remains of springs which have long since ceased to flow. We pitched our camp upon a grassy terrace at the base of the principal group of active springs. Just in the rear of us were a series of reservoirs or bathing-pools, rising one above the other, semi-circular in form, with most elegantly scalloped margins composed of calcareous matter, the sediment precipitated from the water of the spring. The hill, which is about two hundred feet high, presents the appearance of water congealed by frost as it quickly flows down a rocky declivity. The deposit is as white as snow, except when tinged here and there with iron or sulphur. Small streams flow down the sides of the snowy mountain, in channels lined with oxide of iron colored with the most delicate tints of red. Others present the most exquisite shades of yellow, from a deep bright sulphur to a dainty cream color. In the springs and in the little channels is a material like the finest Cashmere wool, with its slender fibres floating in the water, vibrating with the movement of the current, and tinged with

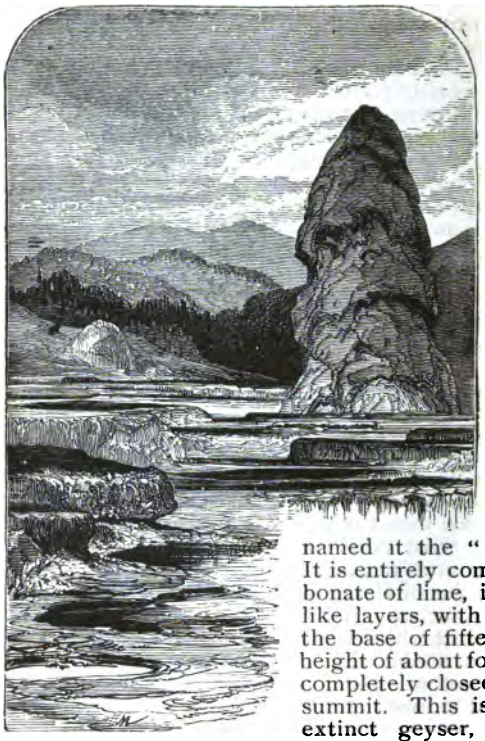
BATHING POOLS. (DIANA'S BATH.)

various shades of red and yellow, as bright as those of our aniline dyes. These delicate wool-like masses are undoubtedly plants, which seem to be abundant in all the hot-springs of the West, and are familiar to the microscopist as diatoms. Upon a kind of terrace covering an area of two hundred yards in length and fifteen in width are several large springs in a constant state of agitation, but with a somewhat lower temperature than the boiling point. The hottest spring is 162°; others are 142°, 155°, and 156°, respectively. Some of them give off the odor of sulphureted hydrogen quite perceptibly. A qualitative analysis shows the water to contain sulphureted hydrogen, lime, soda, alumina, and a small amount of magnesia. It is beautifully clear and slightly alkaline to the taste.

The water after rising from the spring basin flows down the sides of the declivity, step by step from one reservoir to the other, at each one of them losing a portion of its heat, until it becomes as cool as spring water. Within

five hundred feet of its source our large party encamped for two days by the side of the little stream formed by the aggregated waters of these hot springs, and we found the water most excellent for drinking as well as cooking purposes. It was perfectly clear and tasteless, and harmless in its effects. During our stay here all the members of our party, as well as the soldiers comprising our escort, enjoyed the luxury of bathing in these most elegantly carved natural bathing-pools, and it was easy to select, from the hundreds of reservoirs, water of every variety of temperature. These natural basins vary somewhat in size, but many of them are about four by six feet in diameter, and one to four feet in depth. With a foresight worthy of commendation, two men have already preempted 320 acres of land covering most of the surface occupied by the active springs, with the expectation that upon the completion of the Northern Pacific Railroad this will become a famous place of resort for invalids and pleasure-seekers. Indeed, no future tourist in traveling over the Far West will think of neglecting this most wonderful of the physical phenomena of that most interesting region.

The level or terrace upon which the principal active springs are located is about midway up the sides of the mountain covered with the sediment. Still further up are the old ruins of what must have been at some period of the past even more active springs than any at present known. The sides of the mountain for two or three hundred feet in height are covered with a thick crust of the calcareous deposit which was originally ornamented with the most elegant sculpturing all over the surface, like the bathing-pools below. But atmospheric agencies, which act readily on the lime, have obliterated all their delicate beauty. Chimneys partially broken down are scattered here and there with apertures varying in size from two inches to two feet in diameter. Long, rounded ridges are also quite numerous, with fissures extending the entire length, from which the boiling water issued forth and flowed over the sides. Thus the sediment was continually precipitated in thin oval layers, so that a section of these oblong chimneys presents the appearance of layers of hay in a stack, or the thatched cabin of a peasant. Some of these chimneys were undoubtedly formed by geysers now extinct; others by what may be called spouting springs, as those which are in a constant state of violent ebullition, throwing the water up two to four feet—a phenomenon intermediate between a boiling spring and a true geyser. The water is forced up through an orifice in the earth by hydrostatic pressure, and, overflowing



THE LIBERTY CAP.

precipitates the sediment around it; and thus, in time it builds up a mound varying in height according to the force of this pressure. One of these cones is very remarkable, surpassing any observed in any portion of the West. From its peculiar form we almost involuntarily named it the "Liberty Cap." It is entirely composed of carbonate of lime, in flexible cap-like layers, with a diameter at the base of fifteen feet, and a height of about forty feet. It is completely closed over at the summit. This is probably an extinct geyser, and was the most powerful one of this group.

Sometimes the orifice is in the form of a fissure 100 to 300 feet in length, and the mound built up by the deposition of the sediment will be of oblong shape. As the mound rises, the hydrostatic force diminishes, until finally the spring conceals itself at the summit, and either becomes extinct or flows out through fissures in the sides. Classed with reference to their chemical constituents, there are two kinds of springs in the valley of the Yellowstone, namely, those in which lime predominates, and those in which silica is most abundant. In respect to beauty of form, the calcareous springs build up monuments that far surpass the others. The stalactites and beautiful fresco-work in the Mammoth Cave of Kentucky are precipitated from springs holding a great amount of lime in solution. The remark-

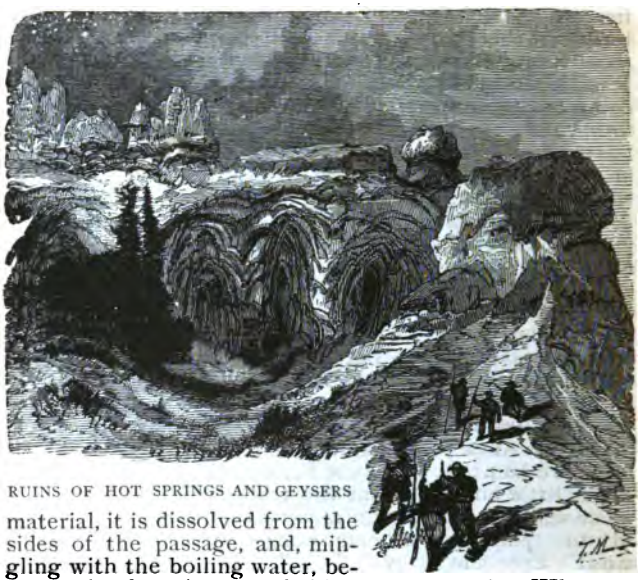
able forms which lime is caused to assume through the influence of water is well known in all limestone regions.

The scenery in the vicinity of these hot springs is varied and beautiful beyond description. I have already stated that they are located 1000 feet above the channel of the Yellowstone, and thus command a very extended view up and down the valley. To the north, the Devil's Slide can be distinctly seen, while on either side the mountains rise to the height of 2000 feet, inclosing the valley as with gigantic walls. From the summit still higher, piercing the clouds, are numerous basaltic peaks, presenting a great variety of unique forms. To the eastward is a bluff wall composed of 1200 to 1500 feet of strata, revealing one of the most perfect geological sections observed in the West. On the summit is a thick cap of basalt which extends over Gardiner's River, and forms the floor over which the waters of the east, middle, and west forks of that stream flow, and dash down in most beautiful cascades.

In the sides of the cañons of these branches are rows of basaltic columns as perfect as those so familiar to all who have visited Fingal's Cave in Staffa. In all my explorations in the Far West I have never seen such exquisite exhibitions of this semi-crystallized structure. Between the middle and west forks stands the dome-like form of Mount Evert, clothed with a dense growth of pines, its summit covered with fragments of basalt. From its top the view is grand, reaching over a radius of fifty to one hundred miles in every direction. On the west are the higher ranges of mountains about the sources of the Gallatin and Missouri forks, with their loftiest peaks covered with perpetual snow.

We must not linger here, however, amid these impressive scenes, but wind our way up the valley in search of more wonders. These will meet us in rapid transition from step to step. We can only stop a moment to glance at one of the greatest beauties of the valley—Tower Falls, or Tower Creek, where the water makes a vertical descent of 156 feet. On either side the sombre brecciated columns stand like gloomy sentinels.

Near this point the Grand Cañon of the Yellowstone River commences, and continues about thirty miles to the Great Falls. In some respects this cañon is the greatest wonder of all. The river has carved out a channel through the basalt volcanic breccia and hot-spring deposits, one thousand to twelve hundred feet deep and one to two thousand feet in width, at the bottom of which the water foams along with torrent-like rapidity. But the striking feature of this remarkable view is the effect of colors derived from the hot-spring deposits, which have a brilliancy



RUINS OF HOT SPRINGS AND GEYSERS

material, it is dissolved from the sides of the passage, and, mingling with the boiling water, becomes in due time much like boiling mush. Whenever the mud becomes so thick as to close up the orifice for any length of time, a sort of explosion takes place, which sometimes hurls masses of the mud to the height of fifty or one hundred feet. At "Mud Springs" and "Crater Mountains" there are several of these mud springs, with basins varying in size from a few inches to thirty feet in diameter, mostly with circular rims and funnel-shaped orifices.

The most interesting of the mud springs occur in the valley of the Fire-Hole Creek. Some of them are filled with very black mud, others a brownish clay; but in a few instances the mud has the snowy whiteness which is due to the decomposition of the silica deposited from the hot waters. To heighten the effect, it is also tinged with the bright red from the oxide of iron. Some of these may be called alum springs, from the fact that the mud is composed largely of alum. Sometimes there will be a group of fifteen or twenty of these little mud springs, with orifices from two to six inches in diameter, all of them operating at the same time with a low thud-like noise.

We made our first camp on the north-east shore of the lake, near the point where the river takes its departure

from it. Here we had one of the finest views of this beautiful sheet of water. This portion of the lake is about ten miles wide. Our camp was located in a broad, open, meadow-like space, with the grass two feet or more in height, adorned with bright flowers having a great variety of colors. A dense growth of pine surrounded it, and to the eastward the range of forest-covered hills was 1200 to 1800 feet above the lake. At this place we launched our little boat, which was destined to perform most excellent service. We had transported the frame-work on the back of a mule from Fort Ellis. We covered the frame with heavy canvas, which rendered it perfectly water-tight, and with this little craft, twelve feet long, three and a half feet wide, and twenty-two inches high, the entire length and breadth of the lake was navigated many times. Soundings of the lake were made in every direction, and the greatest depth discovered was three hundred feet. Messrs. Elliot and Carrington

YELLOWSTONE LAKE.

made a survey of the shore-line from the boat, and, with the numerous bays and indentations, they estimated the distance to be about one hundred and seventy-five miles. So far as beauty of scenery is concerned, it is probable that this lake is not surpassed by any other on the globe. There is not space in the present article to make more than this passing allusion to it; but we hope at some future time to do more ample justice to this region, and trust that the few isolated facts which we now skim from the surface will sharpen curiosity for the complete account.

While some were making an exploration of this beautiful lake, the writer, with a small party, made a trip over the high divide between the waters of the Yellowstone and Missouri rivers, into the Fire-Hole Basin. We had already encountered many of the difficulties attendant upon traveling in this rocky and densely wooded region, but we were not prepared for the impediments which seemed to block our pathway everywhere. We were without a guide, and endeavored to make our courses with a compass. The autumnal fires sweep through the dry pines at times so that many square miles are covered with dead trees. These are soon blown down by the winds, and their long bodies are lodged upon each other in every possible direction. Sometimes these fallen pines are piled up in a sort of irregular net-work, for six or eight feet in height, presenting insurmountable obstacles in the way of the traveler. Then again the small pines grow so thickly that it seems almost impossible to find an interval between so wide as to admit a pack-animal with his load. The traveler may thus wind about among the fallen pines or the dense growth of living trees for an entire day, and yet at night find that he has not made a distance of more than five or six miles in a straight line. After encountering many obstructions, we arrived at the Fire-Hole Basin, and spent five days in exploring its wonders, making charts, sketches, photographs, and taking the temperatures of the springs. The boiling-point of water at this elevation is about 192° to 196°. We ascertained the temperatures of more than six hundred hot springs in this valley, and there were as many more that were dying out, to which we did not think it worth while to give our attention. Many also must have been overlooked by us; so that within an area of about five miles square we may estimate the existence of about 1200 to 1500 springs, with basins of all sizes, from a few inches in diameter to three hundred feet. The springs in this valley are of three kinds, but varying much in their active power: 1st, those

GREAT SPRING, FIRE-HOLE BASIN.

in which the ebullition occurs only at intervals, and which may therefore be called intermittent springs; 2d, such as are constantly boiling and bubbling up, therefore permanent springs; 3d, those whose surface is always undisturbed, and in which there is no bubbling or boiling up. The first class reach the boiling-point only when in operation—when in a state of repose the temperature of the water is as low as 150°. The second class have a temperature equal to boiling water, or not far below it—in this region, varying from 180° to 196°. Some of the largest of the springs are in a constant state of agitation. One of the largest in the Fire-Hole Basin is represented in the accompanying sketch. The basin is about two hundred feet in diameter, and the sides of the crater, which have been much b oken down, are about thirty feet deep. The crater is so filled with dense steam that it is only at periodical times that it is cleared away so that one can catch a glimpse of the seething caldron below. From one side of it five streams of water are ever flowing, which in the aggregate form a river ten feet wide and two feet deep. The delicate shades of coloring from the iron and sulphur are most finely displayed upon the surface over which this water flows.

But perhaps the most striking exhibition of nature's forces in this wonderful region is that of the "Grand Geyser," which is well shown in the accompanying illustration. While we were in the Fire-Hole Valley this geyser played only at intervals of about thirty-two hours; but when it was in active operation the display was grand beyond description. As we stood near the crater or basin, it threw up, with scarcely any preliminary warning, a column

of hot water eight feet in diameter to the height of two hundred feet ; and so steady and uniform did the force act,

THE GREAT GEYSER OF THE FIRE-HOLE BASIN.

that the column of water appeared to be held there for some minutes, returning into the basin in millions of pris-

matic drops. This was continued for about fifteen minutes, and the rumbling and confusion attending it could only be compared to that of a charge in battle. The steam poured out in immense masses, rising in clouds a thousand feet or more in height. After the Grand Geyser had ceased playing, the water of the basin retired from the surface, and the temperature fell gradually to 150°. Another geyser in the same group, and named by the Langford party "Old Faithful," was far more accommodating, and played at intervals of only an hour, throwing up a column of water at least six feet in diameter and one hundred and fifty feet high, for a period of about fifteen minutes. The ease with which this column of water was sustained at the great height during the period of its operation rendered it a marvel of beauty as well as of power.

We may say, in conclusion, that we have been able in this article to do little more than to allude to a few of the wonderful physical phenomena of this marvelous valley. We pass with rapid transition from one remarkable vision to another, each unique of its kind and surpassing all others in the known world The intelligent American will one day point on the map to this remarkable district with the conscious pride that it has not its parallel on the face of the globe.—*Scribner's Monthly.*

THE DIAMOND GRAVELS OF SOUTH-AFRICA.

MR. G. W. STOW showed that both igneous and metamorphic rocks had supplied the material of these gravels. The author concluded that a large proportion of these materials have traveled long distances, probably from the Draakensberg range; but, whether the original matrix of the diamonds is to be found in the distant mountains or at intermediate spots in the valleys, the worn and crushed condition of some of the diamonds indicates long travel, probably with ice-action. Polished rock-surfaces and striated bowlders, seen by Mr. Gilfillan, corroborate this view.

RED OXIDE OF ZINC OF NEW-JERSEY.

BY A. A. HAYES.—This mineral, which has been known for some forty years, has often been the subject of scientific research on account of its peculiar color, and the contents of this memoir are mainly devoted to the discussion of the cause of that color. The composition of the mineral, in 100 parts, is: Oxide of zinc, 93·48; protoxide of manganese, 5·50; scales of specular iron, 0·44; ferric deutoxide, 0·36; loss, 0·22. According to the author, the color exhibited by this mineral is due to a silicate of zinc,

calcium, and ferric oxide, which is dispersed through the mineral in mica-like fashion. Some specimens of the mineral carnallite present a full rich red color, due to a similar cause, namely, the mica-like dispersion of specular iron scales through it.

MAMMOTH FOUND IN CANADA.

DR. ALEXANDER M. ROSS, of Toronto, is in possession of the fossil remains recently found near Millbrook, a town about fifty miles east of Toronto. The earth immediately around the bones was quite dark, and contained large numbers of earthworms. The soil surrounding the mound is a light clay loam, and has been under cultivation for forty years. The bones prove to be the remains of the extinct mammoth, or *Elephas Americanus*, of the quaternary period. The teeth are quite sound, and consist of two molars of the lower jaw and one of the upper jaw. Each tooth has a well-preserved grinding surface of seven and a half inches in length by three and a half inches in breadth, and measures twenty inches in circumference, and weighs six pounds. The portion of tusk found is well preserved, and nine inches in length by six in width. The pieces of leg-bones are much more decayed than the teeth. Dr. Ross says, "This is the first instance, I believe, in which fossil remains of this species have been found in Ontario. Remains of the *Mastodon Giganteus*, that great extinct proboscidian that played so conspicuous a part in the post-glacial period, have been found on several occasions in Canada."

NATIVE DEPOSIT OF GLAUBER SALT.

NOESCHEL has discovered a deposit of native glauber salt in the Caucasus. This singular deposit is on the right side of the Jover, some three or four versts (Russian miles) from the high and steep river-bank, near the military settlement of Muchrevan, 20 or 25 versts from Tiflis, and 10 versts from the German colony of Marienfeld. The spot where it is found is a bowl-shaped depression, half a square verst in extent, 60 feet deep, destitute of vegetation, and surrounded by wave-shaped hills, except on the west side, where the meteoric water can flow off. A boring gave the following result: Marl, 1 foot; gray moist clay, 2.5 feet; dark gray, bituminous, salty clay, 0.7 feet; pure glauber salt, 5 feet. It is probable that the thickness of this wonderful stock of salt is very much greater. Three other borings at distances of 60 to 80 fathoms gave the same result, and Noeschel estimates the total amount at not less than fifteen and a half million cubic feet.(15)

CUTTING STONE WITH DIAMONDS.

A PLAN for cutting mouldings in stone, suggested by Alonzo S. Gear, consists in using a small vertical revolving spindle armed on all sides with diamonds. The stone to be cut into mouldings is presented to this spindle in the same manner as wood is to a gig-saw, and it is acted on in the same manner except that the spindle revolves instead of reciprocating. It may, however, have a small endwise motion if preferred. Intaglio figures may be made in the faces of stone by the use of a cutter-head armed with diamonds under which the stone is moved by hand or otherwise, according to the lines in the design to be produced.

TAMMITE OR FERRO-TUNGSTINE.

BY HUGO TAMM.—Ferro-tungstine is a dark, steel-colored, heavy crystalline powder, formed of separate and distinct crystals, presenting exactly the appearance of crystallized silicium. Its specific gravity, which is considerable, is 12·5. It is a very hard substance, which can only be porphyrized with extreme difficulty, and it is almost impossible to reduce it to an amorphous powder; the powder obtained after a prolonged porphyrization remaining still bright, like the powder of a crystalline metal or alloy, and crystalline.

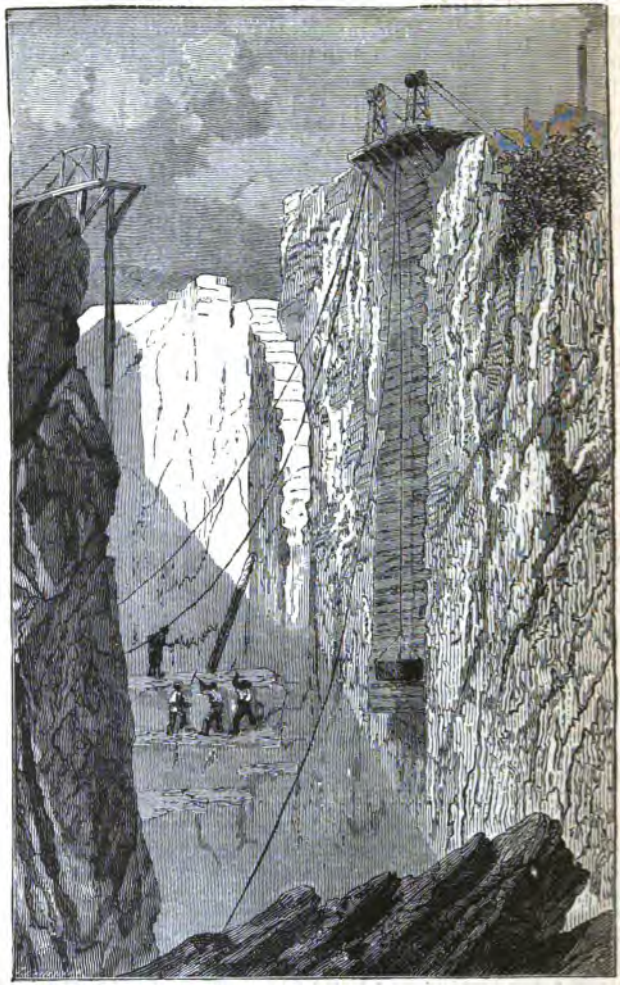
Heated in the air at a low red-heat, ferro-tungstine slowly oxidizes, and is converted into a yellow powder of tungstic acid; and when it is thrown in fused nitre, it burns with brilliancy and is thoroughly attacked

Ferro-tungstine is composed of—

Metallic tungsten	88·05
Metallic iron	5·60
Metallic manganese	0·15
Undetermined substance	6·20
(a)	100·00

THE SLATE QUARRY OF ANGERS.

ALTHOUGH slate is found in almost every part of the world, and yields most readily to the efforts of the miner to detach it in natural tablets, the quality varies so much in different localities that in some places it is quarried in truly enormous quantities and exported to the most distant countries. Wales long provided this country with the required supplies—vessels on their return from Liverpool, after discharging their cargo of cotton, often stopping at Bangor for a load of slate from the quarries in its vicinity. But the useful rock is now mined in a long line of valuable quarries extending from Vermont through New-York, Pennsylvania, and Virginia as far south as



THE SLATE QUARRIES AT ANGERS, FRANCE.

Georgia. A quarry in France, near the town of Angers, holds a kind of supremacy over all rivals in Europe. It has been worked for centuries, and still the supply is apparentl

endless; it surpasses others, even Col. Pennant's famous quarries in Caernarvonshire, with their 2500 miners, by the number of persons employed, the superior quality of its produce, and the amount it exports to foreign lands. The quarry represents a huge cavity in the earth, the walls of which rise perpendicularly to an immense height. Workmen, who spend their lives in the lower parts of the huge gaping abyss, detach the valuable material, by the aid of ingenious instruments, in beautiful large, smooth plates, which are hoisted by steam machinery to the surface, and there prepared by another set of skillful workmen for their future usefulness.

FOSSIL VERTEBRATES.

PROF. LEIDY has founded a species of lion, *Felis augustus*, on several teeth and fragments of jaws discovered by Dr. Hayden at the Loup Fork of the Niobrara, Nebraska. The most characteristic specimen is an upper sectional molar about as large as that of the Bengal tiger. He also describes one of the caudal vertebræ of an animal related to *Plesiosaurus* and *Discosaurus*; and regarding the specimen as probably representing a genus different from those mentioned, he proposes for the species the name *Oligosimus grandaevus*. Another specimen obtained by Dr. Hayden in the "Black Foot country," at the head of the Missouri, has the appearance of having formed part of the dermal amour of a huge saurian, or possibly of an animal allied to the armadillo. Accompanying this specimen is a distal phalanx, which may belong to the same species, named *Tylosteus ornatus*.

TIN AND COPPER MINES.

BY providential provision the most useful of metals, iron, is the most universal of the hidden treasures of the earth, so that no part of our globe is entirely without it, and a full supply is within reach of the poorest. It is not so with copper, which, though far less useful by itself for the practical purposes of life, becomes eminently serviceable in its willing union with other metals, and appears now as brass or bronze, and now as alloy with nearly all the gold and silver we employ in daily life. The two most remarkable copper-mines of the world are our own on Lake Superior, where nature's liberality is shown most strikingly by her lavish gifts of magnificent masses of almost pure copper, and those of Falun, in Sweden, where the valuable metal is extracted mainly from pockets, with incredible labor, and at an enormous expense of capital. In the very centre of the town a huge gulf yawns heavenwards,

measuring more than a thousand feet in width and length, and over two hundred feet deep, so that the miners work

MINE AT LAND'S-END, CORNWALL, ENGLAND—EXCAVATED UNDER THE SEA.

for the most part in the open daylight. Where this is impracticable, ladders, apparently endless, are fastened to

the rocky walls, and the poor miners have to descend slowly and painfully, by the light of feeble torches, constantly threatened with a horrible death if their feet should for an instant waver and slip from the ever-damp rungs on which they step alternately.

One of the most remarkable tin and copper mines in the world is that at Land's-End, Cornwall, England, known as the Bottalack mine. We give a sketch thereof. The shafts are on the verge of the cliff, which is exposed to the full fury of the ocean. The workings are carried vertically down below the tide-water, and are then extended horizontally under the sea for several hundreds of feet. The dashing of the waves is distinctly heard by the miner at his work, and in stormy weather the rolling of the stones on the sea-bottom above his head, produces a noise like thunder. The mines of Cornwall are among the most valuable in the world.

THE PRIMORDIAL GROUP OF CANADA.

THE St. John's, or Primordial bed, the most interesting of all the formations originally recognized as distinguished from the adjacent beds by Mr. Matthew, was first proved to be Primordial by Prof. C. N. Hartt. His discoveries with regard to the fossils, added to those previously obtained, enabled him to announce this conclusion with full confidence, the species of *Lingula, Paradoxides, Agnostus, Conocephalites, Obolellae, etc.*, placing it beyond doubt. The formation mainly consists of shales, and is stated to be over 2000 feet in thickness. It occurs in southern New Brunswick, in the depression extending from the city of St. John by way of the Loch Lomond lakes to Hammond river, in the valley of the Kennebecasis and St. John's rivers, in St. John's and Northern King's counties, and perhaps also in the Nerepis valley, as well as at some other points. The strata of these districts are described in detail in the Report of Progress for 1870–71 of the Geological Survey of Canada.

GEOLOGY OF THE ARGENTINE REPUBLIC.

ACCORDING to Dr. G. A. Maack, the great La Plata plain chiefly consists, along its western border, of alluvial deposits from one to two feet in thickness, and generally formed of a fine brown or gray silt "Pampa sand," made up for the most part of diatomaceæ, and, in the neighborhood of rivers, some still living fresh-water shells. This covers the diluvium, the real Pampas formation, ("formation pampéenne" of d'Orb, "Pampean mud" of Darwin.) More or less red in color, and attaining a thickness of 10 to 60 feet,

it consists of sand and clay, and in some parts limestone in so-called "Tosca concretions," and is remarkable for its "Lagunas" or "Salinas," and the gigantic remains of *Megatherium, Mylodon, Glyptodon, Toxodon*, etc. The basis of this Pampas deposit is formed of Tertiary beds, which d'Orbigny divided into a *système guaranien* and *système patagonien*. To the former may belong the lignite beds of Rio Grande do Sul, in Brazil. The latter group is best developed in the neighborhood of Paraná, and near Vivoras, in Uruguay; its chief fossils are *Venus Münsteri* and *Ostrea Patagonica*, and the formation may be ranked beside the Swiss molasse. Tertiary beds are found at a depth of 280 feet at Buenos Ayres, whence they seem to extend right away to the base of the Cordilleras. Other sedimentary rocks are unknown in the Pampas, though the older Plutonic rocks are met with at isolated spots. (57)

ORIGIN OF COAL.

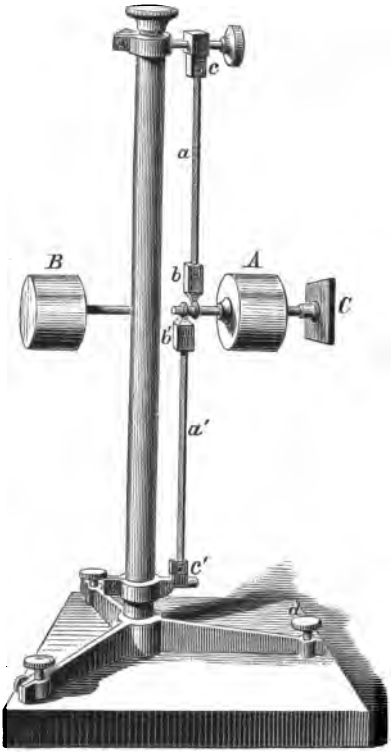
ACCORDING to Professor Würtz, the formation of coal depends entirely upon the action of the iron which was dissolved in the waters of the coal period. The combinations of iron with which coal is always accompanied are pyrites, iron spar, and hydrated oxide. These were doubtless derived from the strata interjected between the coal-beds. In this case the oxygenated water appeared to act upon the metallic sulphurets which were contained in the crystalline slates, from the destruction of which these coal strata were derived. Coal, consequently, is the normal result of the eremacausis of organic substances in waters which contain sulphate of iron and free carbonic acid. An immense pressure upon the mass, while in a plastic condition, was also, without doubt, an additional element of importance.

M. SAPORTA has come to the conclusion, from a careful examination of the fossil plants of the Oolitic or Jurassic epoch in France, included equisetums, ferns, conifers, and cycads, that that country enjoyed a mean temperature of 25° Centigrade—nearly the same as that now prevailing in tropical countries.

A NEW FOSSIL BIRD.—Prof. Marsh has described the skeleton of a large fossil bird, standing at least five feet high, which he met with in the Upper Cretaceous deposits of Western Kansas. Although a true bird, it differs widely from any known recent or even extinct form. The name he proposes to give to it is *Hesperornis regalis*. In many respects, this unique fossil he considers to be most comprehensive in its relationships.

ASTRONOMY.

ZOLLNER'S HORIZONTAL PENDULUM.



M. F. ZOLLNER communicates to the English *Philosophical Magazine* a paper on the origin of the earth's magnetism and the magnetic relations of the heavenly bodies, in which he describes a method by which he considers we are enabled to measure even those small forces which are, for instance, produced by the difference in distance between any point on the earth's surface from sun or moon and the distance of the earth's centre of gravity, or by difference in the centrifugal force of two points at different distances from the earth's surface.

The apparatus is represented in the accompanying engraving; *a a'* are thin watch-springs held in continual tension by the weight *A* with the mirror *C* in front. The stand is made of iron, and the feet of the tripod are as long as possible, in order to effect very small changes in position of the points of suspension with regard to the direction of gravitations by the slow movement of the screws. By means of the screw *d*, situated in a vertical plane passing through the two points of suspension *c* and *c'*, the sensitiveness of the instrument may be governed, as by the relative position of the points *c* and *c'* the time

of vibration of the horizontal pendulum is determined. A time of vibration of 30 seconds (half a period) is easily accomplished. *B* is a counterpoise of *A*. Before the oscillating mass *A* and the parts belonging to it were placed in the rings, which fit into small incisions cut into the cylindrical axis, it was set in vibration by the direct action of gravity round a knife-edge occupying provisionally the place of the turning-point. The time of oscillation amounted to nearly 0.25 of a second. By means of a known relation, the ratio of moments of direction are thus easily obtained which are exerted by gravity on the vibratory mass in the horizontal and vertical directions. The mirror attached to the end of the pendulum allows the reading off of the changes in the direction, according to the method of mirror-reading, on a scale 3186 millimetres distant from the mirror. With regard to the above-mentioned time of vibration of 0.25 second, it was calculated that a millimetre division on the scale corresponds to a deviation of 0.0097063 second of an arc of an ordinary pendulum. The instrument is so extremely sensitive that deviations of only 0.001 second of an arc may be obtained even with a time of vibration of 14.44 seconds.

Observations are best made in deep and quiet mines, where the variations of temperature and shakings of the earth are absent, and all those influences can therefore be determined quantitatively which are caused either directly by volcanic movements of the ground or indirectly by magnetical induction through changes in the velocity of the streaming masses on the inner part of the earth. Besides the generation of an inner tidal and pressure wave, the sun and moon exert a direct influence on the positions of the instrument, because they attract with different intensity the centre of gravity of the earth and the centre of gravity of the pendulum. We may thus expect to determine the magnitude on which these influences depend by a much extended and statistically headed series of observations—that is to say, the masses and distances of sun and moon in units of the mass and radius of the earth.

Supposing the instrument set up in the meridian, the pendulum, if moving only under the influence of the sun, would pass in twenty-four hours four times through its position of equilibrium in the meridian—at sunrise, sunset, and at the upper and under passage of the sun through the meridian. As the movement of the pendulum is not an effect of summature, as that of the sea in the tides, but is generated directly by attractive action at a distance, it must take place simultaneously with the corresponding true position of the sun. But if gravity, as light, takes a

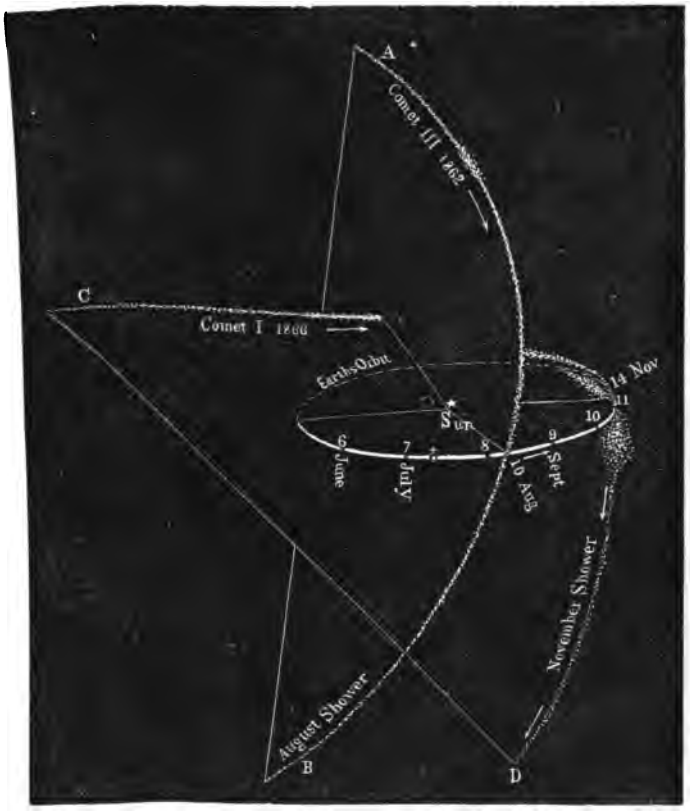
time of about eight minutes in arriving from the sun to the earth, the above position of equilibrium would take place so much later. If, therefore, we only succeed in determining these positions to within one minute of accuracy, the question whether gravity needs time for its propagation could be decided even if this velocity were ten times that of light.

The discussion of observations made simultaneously in two vertical circles with the horizontal pendulum and their comparison with the readings of magnetical instruments, will supply valuable material tending to elucidate the causes of the close relation between the mechanical, electrical, and magnetical phenomena on our planet: the explanation of which will perhaps some day give us as clear a conception of the occurrences in the earth as the language of signs of the senses, chiefly by the help of light, has given us of the occurrences on its surface.

THE AUGUST AND NOVEMBER METEORS.

SCHIAPARELLI has discovered so close a resemblance between the path of the August meteors and that of the comet of 1862, No. III., that there can not be any doubt as to their complete identity. The meteors to which we owe the annual display of falling stars on the 10th of August are not distributed equally along the whole course of their orbit; it is still possible to distinguish the agglomeration of meteoric particles which originally formed the cometary nucleus from the other less dense parts of the comet; thus, in the year 1862 the denser portion of this ring of meteors through which the earth passes annually on the 10th of August, and which causes the display of falling stars, was seen in the form of a comet, with head and tail as the densest parts, approached the sun and earth in the course of that month. The difference between the comet's nucleus and its tail that has now been formed into a ring, consists in that, while the denser meteoric mass forming the head approaches so near the earth once in every 120 years as to be visible in the reflected light of the sun, the more widely-scattered portion of the tail composing the ring remains invisible, even though the earth passes through it annually on the 10th of August. Only fragments of this ring, composed of dark meteoric particles, become visible as shooting-stars when they penetrate our atmosphere by the attraction of the earth, and ignite by the compression of the air.

Calculation shows that this ring of meteors is about 10,948,000,000 of miles in its greatest diameter, and that the breadth of this ring at the place where the earth crosses it is 4,043,520 miles.



The calculations of Schiaparelli, Oppolzer, Peters, and Le Verrier have also discovered the comet producing the meteors of the November shower, and have found it in the small comet of 1866, No. I., first observed by Tempel, of Marseilles.

According to Le Verrier, a cosmical nebulous cloud entered our system in January, A.D. 126, and passed so near the planet Uranus as to be brought by its attraction into an elliptic orbit round the sun. This orbit is the same as that of the comet discovered by Tempel, and calculated by Oppolzer, and is identical with that in which the November group of meteors make their revolution.

Since that time, this cosmical cloud, in the form of a comet, has completed fifty-two revolutions round the sun, without its existence being otherwise made known than by the loss of an immense number of its components, in the form of shooting-stars, as it crossed the earth's path.

The orbit of this comet is much smaller than that of the August meteors, extending at the aphelion as far as the orbit of Uranus, while the perihelion is nearly as far from the sun as our earth. As the earth encounters the comet's tail, or meteoric shower, for three successive years at the same place, we must conclude the comet's track to have the enormous length of 1,772,000,000 of miles. The above is from Schellen's *Spectrum Analysis.*

In August, 1872, a considerable number of meteors was observed in the United States and in other countries; but the meteoric display of November, 1872, was much finer. At Yale College, New-Haven, Ct., at Vassar College, Poughkeepsie, N. Y., and at many other points between the Atlantic and Pacific, many thousands of meteors were observed. Far out at sea, in various quarters, the shower was brilliant.

At Münster, in Westphalia, in the short space of fifty-three minutes, 2200 meteors were counted by two observers. In Jutland, one observer counted 2400 in an hour. At the Göttingen Observatory, 7710 were seen in about three hours. Look out for the meteors again in 1873.

NEW OBSERVATORY AT FLORENCE.

On the hill of Arcetri, the scene of the labors of Galileo Gallilei during the later years of his life, has been constructed a well-arranged observatory, under the care of Donati. This scientific establishment has been inaugurated in the presence of a number of distinguished men, worthy representatives of a nation which follows the steps of those illustrious *savants* whose labors have rendered Italy, and especially Florence, renowned in the annals of science.

A PLANET BETWEEN MERCURY AND THE SUN.

It has for some time been suspected by astronomers that there was a small planet revolving about the sun, between that luminary and the orbit of Mercury, and with a period of revolution of about 20 days. Mr. J. R. Hind, the Astronomer Royal, has called especial attention to the subject, and suggested that, on March 24th, 1873, the sun's disk should be watched, as a conjunction of this hypothetical planet with the sun is expected to occur about 10 A.M. on that day.

In the *Scientific American*, Mr. John H. Tice, an astronomer of St. Louis, Mo., writes as follows: "In the latter half of September, 1859—I cannot now fix the exact date, though it may have been about the 20th—I saw the planet pass over the disk of the sun. I first saw it about nine o'clock, my attention being called to it by some boys who were looking at the sun through a smoked glass. It was then on the eastern limb, and its apparent diameter was about 2¼ inches. It took it about two hours to pass over the sun. As it is impossible for any of the known inferior planets to pass over the sun in the month of September, it must have been an unknown planet. I communicated this fact to the naval professors in 1869, requesting that search be made for this inferior planet at the eclipse of that year, but nothing was ascertained.

ASTRONOMY IN THE MOUNTAINS.

PROFESSORS YOUNG AND EMERSON, of Dartmouth College, spent the summer vacation in astronomical observation at Sherman, the highest point on the Pacific Railroad, (elevation, 8300 feet,) in connection with a party of the United States Coast Survey. They report a very agreeable and successful excursion, and found all the expected advantages in the altitude of the station.

A careful examination of the various test-objects proved that at Sherman the Dartmouth telescope, with its 9 4-10 inches of aperture, would show every thing which can be seen in New-England with a 12-inch object-glass. The views of Saturn and the moon, as well as of double stars, clusters and nebulæ, were exquisitely beautiful.

Professor Young's principal work, however, was with the spectroscope, and was successful even beyond his anticipations. The solar prominences and chromosphere were seen far more clearly than ever before, and their wonderful transformations and motions were studied with new interest. Secchi's "layer of continuous spectrum at the sun's limb" was repeatedly verified, and although there was no occasion when all the Fraunhofer lines appeared reversed, this was nearly the case more than once. In the spectrum of the chromosphere 165 new bright lines were discovered, raising the total number now known to 268. Of the 103 previously known, all but about 30 were first catalogued at our own observatory.

The most interesting of the new observations is probably the discovery of the permanent reversal of the so-called H lines in the spectrum of the chromosphere, and the yet more remarkable fact that the same lines are reversed on the surface of the sun itself over a pretty large region sur-

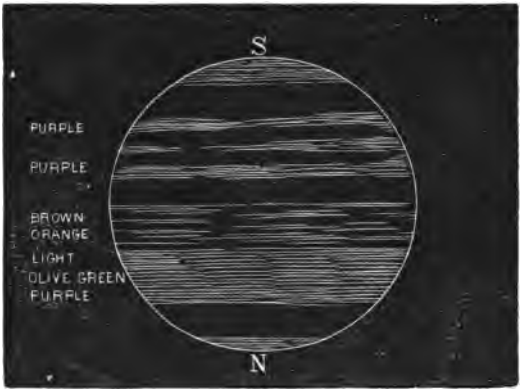
rounding every spot. It is doubtful whether these observations upon lines at the extreme purple end of the spectrum can be verified by instruments near the level of the sea, but even if not, there can be no possible mistake as to the fact. (37)

AUTOMATIC MERIDIAN TIME-ADJUSTER.

By an ingenious invention of John A. Miller, a watch-movement, wound up, and having its hands set at 12 o'clock, has its balance-wheel held in check by a spring detent, held by an inflammable thread in such relation to the focus of an adjustable lens that when the sun passes the meridian the rays from it pass through a narrow slot upon the thread, which, being burnt, will release the stop and allow the watch to mark time from that point. Instead of the thread a pin of shellac or other substance that will melt easily may be used. If a watch of that class which stops on the "dead-point" is used, the stopping device should be so arranged as to give the balance-wheel a slight movement when it is released.

THE PLANET JUPITER.

W. Lassell, Esq., ex-President of the Royal Astronomical Society, has published some observations, with a sketch of the planet as seen by him in his 2-feet Newton-



ian reflector, with powers of 260, 430, and 579. These observations were taken on the interesting occasion of a transit of the fourth of the satellites across the planet's disk when the satellite appeared almost as black as if it were a shadow transit—a striking proof of the exceeding brilliancy of the planet's surface. But this was not the phenome-

non that appeared most striking in the rare and exquisite view of Jupiter, but rather the distinct presence of color on the disk, sufficiently marked to overcome previous skepticism. Mr. Lassell deems it an advantage of a Newtonian reflecting telescope, when the alloy of the specula is well compounded, that colors of the planets are more faithfully represented than is possible in refracting telescopes, which, not being perfectly corrected for chromatic aberration, generally introduce a modifying tinge. (83)

MAGNETIC RELATIONS OF THE HEAVENLY BODIES.

ZOLLNER says: Generalizing the results we have arrived at, taking into account the general similarity in the history of development of all the larger heavenly bodies, we may express this generalization in the following terms:

All rotating heavenly bodies possess magnetical poles which do not coincide exactly with the poles of rotation. During the gradual cooling the polarity changes signs, so that a glowing liquid body possesses the opposite polarity to that of one which is covered by a solid crust.

The magnetic polarity disappears—first, when the change of signs takes place, that is, in that phase where, as in the stars of variable brightness, the slag-like masses have already taken the character of extended continents; and secondly, when the nucleus has become entirely solid. After these considerations the existence of a magnetical relation between the planets and the sun is, from the stand-point of my theory, to be regarded, at least qualitatively, as a physical necessity.

It is a necessary consequence of my theory that at the times of sun-spot maxima the relative velocity and the friction of the currents is increased; and hence the intensity of the electrical currents produced, as well as the magnetism of the sun, is greatest at those times.

HYDRO-CARBON FROM METEORIC STONES.

BY NEVIL STORY-MASKELYNE.—The question as to whence the meteorites come is one that we are not yet in a position to answer with certainty. The various hypotheses which suppose for them an origin in lunar volcanoes, or in our atmosphere, or again in a destroyed telluric satellite, or that would treat them as fragments of an original planet of which the asteroids are parts, or as masses rejected from the sun; all these hypotheses seem to be more or less precluded by the known velocities, the retrograde motion so frequently characterizing

meteors and meteorites, or else by the chemical conditions that, for instance, are involved in the passage of the meteorite through the sun's chromosphere. Whether meteorites move or do not move in circumsolar orbits is at present impossible to say; because, while with our incomplete knowledge we can not to-day attach the character of periodicity to any known class of meteorites, we are not justified in founding any conclusion on a negative result with so limited a foundation.

It may, however, be said, that the tendency of scientific conviction is in the direction of recognizing the collection toward and concentration in definite centres of the matter of the universe, as a cosmical law, rather than the opposite supposition of such centres being the sources whence matter is dispersed into space. In the meteorites that fall on our earth (certainly in considerable numbers) we have to acknowledge the evidence of a vast and perpetual movement of space, about which we can only reason as part of a great feature in the universe which we have every ground for not supposing to be confined within the limits of the solar system.

The meteorites we know have, probably all of them, been originally formed under conditions from which the presence of water or of free oxygen to the amount requisite to oxidize entirely the elements present were excluded; for this is proved by the nature of the minerals constituting the meteorites and by the way in which the metallic iron is distributed through them.

And one suggestive and significant fact remains to be alluded to; the presence, namely, in some few meteorites of combinations of hydrogen and carbon, which if met with in a terrestrial mineral would with little hesitation be assigned to an organic origin. A few grains were exhibited (Royal Inst.) to the audience of such a body, crystallized from ether, which solvent had extracted it to the amount of about 0·25 per cent from 6 ozs. of the Cold Bokkveldt meteorite.

Similar substances have been extracted by Wöhler, Roscoe, and other chemists from this and other meteorites. It was, however, observed, as pointing to the probability of the comparatively porous meteoric stone having in this case taken up the hydrocarbon as a substance extraneous to it, (possibly when in the state of a vapor,) that ether extracted it entirely from the solid lumps of the meteorite; pulverization not in any way adding to the amount obtained, or facilitating in any appreciable degree the separation of the substance.

MISCELLANEOUS.

AIR-POWER.

A LETTER from Brunswick, Me., to the Portland *Argus*, gives the following information relating to the use of air as a motive power in that village:

On the Androscoggin River, some three fourths of a mile below the railroad station, is the site of a mill long since burned, and the motive power which operates the condenser is a water-wheel at the place. The wheel, it is said, is capable of driving four condensers of equal power with the one now in use. But it is only with results already accomplished that we have to do. At the railroad station is an engine of ten horse-power, running circular saws for sawing wood and various machinery in the blacksmith-shop in the vicinity. Thence a small pipe passes on through the village, furnishing power to Worthly Brothers, jewelers, who are running a small engine of about one horse-power; Parent and Dafriend also use an engine of two horse-power in their blacksmith-shop; Dennison & Co., box-makers, an engine of two horse-power, and Professor Brackett, of Bowdoin College, one of three horse-power, for the manufacture of instruments, while the laboratory of the college has one of six horse-power. So that, nominally, this small condenser furnishes in all twenty-four horse-power, and all unite in saying that the air-power is much more efficient than steam in working the same engines; it does not drag, but recovers itself instantly from any strain or check, and is in every way a success.

The employment of pneumatic power, says the *Scientific American*, for industrial purposes, is constantly increasing. By its use the Mt. Cenis tunnel through the Alps, seven miles in length, was bored. The Hoosic tunnel, in Massachusetts, five miles in length, now nearly finished, is being cut by the same means. The St. Gothard tunnel, in Switzerland, lately commenced, which is to be thirteen miles in length, will also be cut by means of compressed air. The Hell-Gate rocks, under the East River in this city, are in process of removal by the same agency. In planing-mills, the pneumatic method is used to carry the shavings from the planers to the furnaces of the steam-boilers; in grain and wool houses, to convey

the stock. At the iron furnaces, pneumatic elevators are used to lift the cars and their loads of ore from one point to another. In London, the pneumatic method drives five-ton freight-cars in tubes under ground; the post-office department of that city has now in use several miles of pneumatic tubes laid under the streets, in which letters are conveyed with great rapidity. In this country the largest scale on which the system has been applied is at the works of the Pneumatic Transit Company, on Broadway, where a railway passenger-car, running in a nine-foot tunnel under that street, is operated by compressed air. For an underground railway this pneumatic method is especially useful; cinders, gas, smoke, dust, noise, and locomotives, all are avoided; the cars may be driven smoothly along with great rapidity. In England, some years ago, during the experimental trials of the pneumatic cars the trains were driven by this method at a velocity of sixty miles per hour. The pneumatic car under Broadway has carried between two and three hundred thousand passengers; but, owing to the shortness of the tunnel, so high a speed can not be reached. As soon as the Legislature grants the necessary authority, the work will be extended through the city from the Battery to Harlem River. New-York will then be able to boast of having the safest, most agreeable, and most rapid means of passenger conveyance of any city in the world.

SLOW PROLONGED ACTION.

By Becquerel.—Metallic, alkaline, and acid solutions were allowed to act upon each other for a number of years, being brought into direct contact within hermetically sealed glass vessels, or separated from each other by cracked tubes, or by porous earthenware.

When solutions of gold or potassium plumbate were made to act upon each other in an electro-capillary apparatus, metallic gold was deposited on one side and red lead on the other side of the partition.

Among the products formed within hermetically sealed vessels, opened only after the lapse of twenty years the most remarkable were:—Arragonite crystals, by contact of gypsum with solution of potassium bicarbonate. Rhombohedral crystals of calcium carbonate, by contact with gypsum with sodium carbonate. Crystals of calcium arsenite, almost as beautiful as those found in nature. Crystals of the double sulphate of calcium and potassium, by contact of potassium aluminate with gypsum. Crystals of lead carbonate, by contact of pieces of galena with potassium bicarbonate. Crystalline scales of hydrated

lead carbonate, by contact of calcspar and potassium plumbate.

On immersing porous plate scalcspar, 1 centimetre thick, into a solution of cupric nitrate, and transferring them with the cuprous nitrate formed within them into a solution of potassium bicarbonate, it was found that the plates, without having changed their structure, were converted into malachite. In order to allow the solution to penetrate thoroughly into the interior of the plates, the carbonic acid and liquid compounds formed had to be removed from the pores by operating *in vacuo*. (4)

THE MECHANICAL PIGEON.

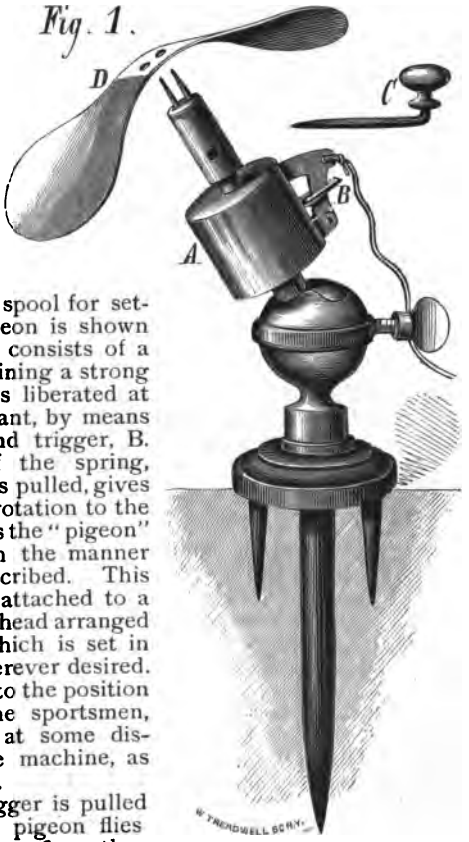
To attain dexterity in the shooting of birds upon the wing, it has been the practice of sportsmen to make use of live pigeons, which are placed in suitable cages, from which by a string they are liberated at the desired moment, to be needlessly shot down by the gunner. The great cruelty of this sport has led to the invention of what is termed the mechanical pigeon, the construction and operation of which is illustrated in the accompanying engravings.

The mechanical pigeon consists of a thin strip of sheet-

iron, six inches or more in length, having wings bent somewhat like the blades of a screw-propeller, as shown at D, Fig. 1. When rapid rotation is given to this propeller, it rises high in the air, the wings are seen to flicker or vibrate, and its whole appearance resembles a flying bird.

To effect the aërial flight of the mechanical pigeon, two methods are employed. One of these, shown in Fig. 2, consists of a spool, A, mounted on a handle, the spool being turned with great rapidity by the application of force to the cord, as shown. Upon the forks of the spool the pigeon is centred, and when a proper rotating velocity is communicated, away it sails into the air, like a bird upon the wing.

Fig. 1.



A self-acting spool for setting off the pigeon is shown in Fig. 1. This consists of a barrel, A, containing a strong spring, which is liberated at the proper instant, by means of the cord and trigger, B. The power of the spring, when the cord is pulled, gives instantaneous rotation to the forks, and sends the "pigeon" into the air, in the manner previously described. This spring spool is attached to a ball and socket-head arranged upon a spike which is set in the ground wherever desired. The cord leads to the position occupied by the sportsmen, which may be at some distance from the machine, as shown in Fig. 3.

When the trigger is pulled the mechanical pigeon flies and the sportsman fires, thus

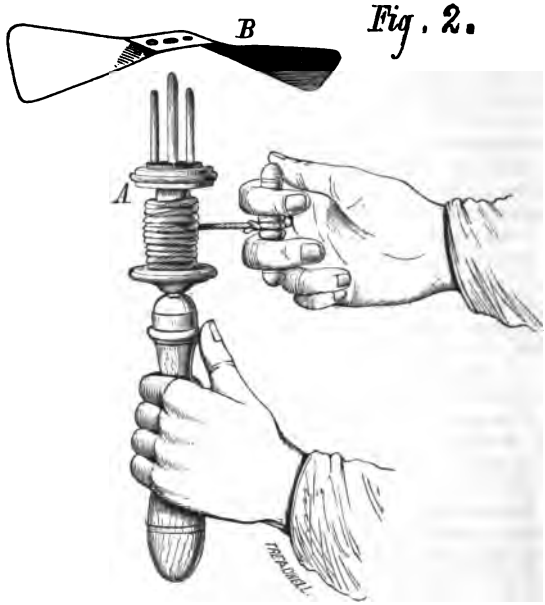


Fig. 2.

enjoying the best of gunnery practice without cruelty to innocent birds. If a shot strikes the mechanical pigeon, its direction is changed, and it falls to the ground. This contrivance has become an extensive article of sporting merchandise.

DISCOVERY OF LIVINGSTONE BY STANLEY.

THE successful accomplishment by Mr. Stanley of the mission intrusted to him by the New-York *Herald*, namely, that of finding and succoring Dr. Livingstone, has created an excitement throughout the civilized world; and the European and American press vie with each other in their commendations of the enterprise undertaken by the journal, and the ability and energy with which it was satisfactorily accomplished by the agent.

Mr. Stanley, after receiving his instructions from the *Herald* to find Dr. Livingstone, "dead or alive," proceeded to Zanzibar, and thence penetrated the African continent, as nearly as possible by the route that Dr. Livingstone was thought to have taken, and arrived at Unyanyembe on the 23d of June, 1871, which was the date of the last

dvices previously received from him. He experienced rawbacks in the sickness and death of his men, which reakened his company very considerably, so that he was lad to join some Arabian caravans on their way to the est. Their progress, however, was impeded by the opposition of Mirambo, an African king, who first insisted n levying black-mail upon the caravans, and finally absoitely refused permission to pass. This involved a war ith the potentate named, in which the combined forces f Stanley and the Arabs were at first successful; but in onsequence of an ambush on the part of Mirambo, the arty was demoralized and put to flight, leaving Stanley l with a fever, and with only nine attendants.

Finding so much difficulty in traveling by the route orinally contemplated, Stanley made a detour, and, after arious adventures, finally succeeded in reaching Ujiji, here, to his delight, he found Dr. Livingstone, in good ealth and condition, and greatly rejoiced at the meetg. The precise date of the arrival of Stanley at Ujiji not mentioned in his dispatches, although he states iat on the 16th of October, in company with Livingone, he left Ujiji, and arrived, November 2d, at Unyiyembe, where they spent twenty-eight days in exoration, returning to Ujiji and passing Christmas-day company, and then leaving again for Unyanyembe on ie 26th of December, where they arrived after fifty-four iys of travel. This journey was for the special purpose enabling Dr. Livingstone to obtain supplies of goods id provisions, which had been sent him from the British insulate at Zanzibar, but which had been detained on the ay a very unnecessary length of time.

Stanley himself, in parting with Livingstone, turned ver to him large quantities of material for presents, and so a portable boat, tools, fire-arms, and ammunition, leavg him on the 14th of March, on his return to Zanzibar. e was commissioned by Dr. Livingstone to forward to him ty well-armed men, to act as soldiers and servants, to acmpany him on a new expedition that he is organizing, hich will occupy about a year and a half, to complete the oblems which remain to be solved before his return. is plan is to proceed to the copper mines of Katanga, en eight days south, to discover the fountains of Herotus, returning by Katanga to the underground houses Rua; thence to Lake Kamolondo, and, after making me explorations in that vicinity, to go back to Lualaba, id by way of Uguhha to Ujiji, and thence to the coast. this work he expected to examine the north shore of nganyika Lake, and the 180 miles of the Chambezi River t visited by him.

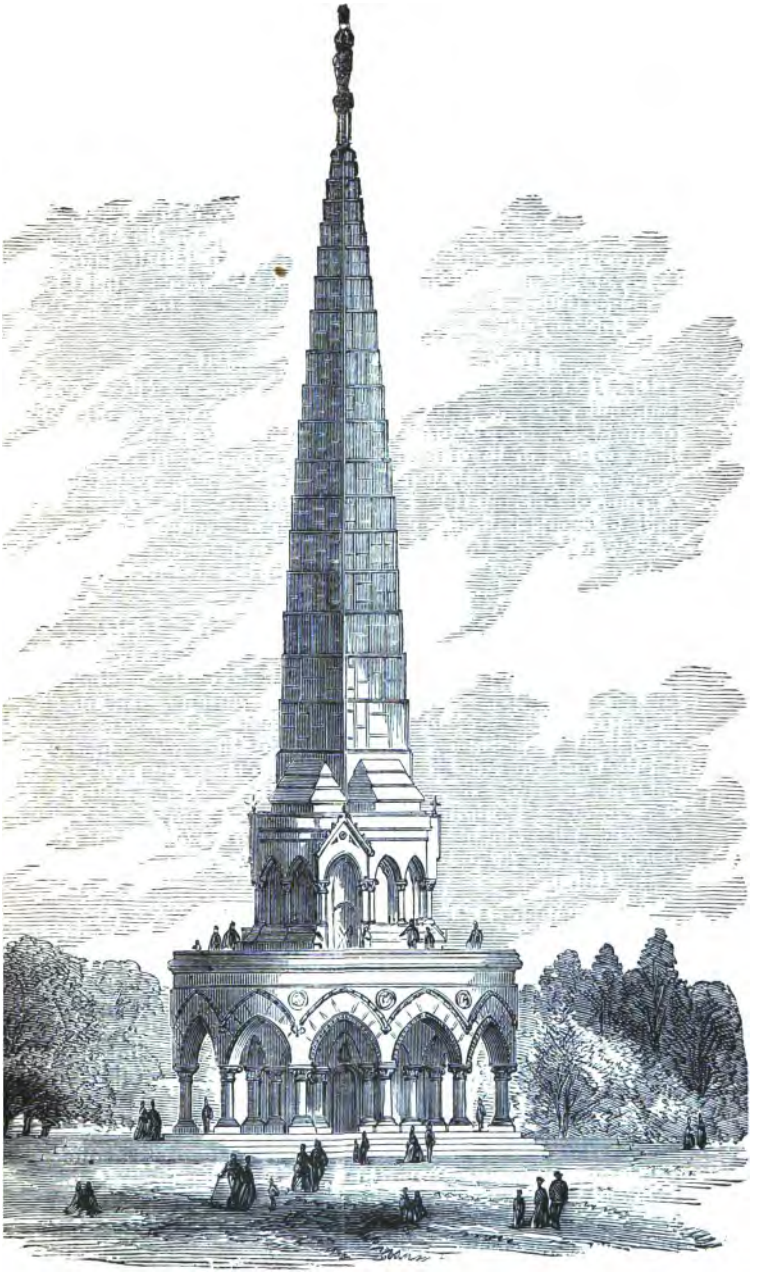
An abstract of Dr. Livingstone's explorations up to the time that Stanley met him, published in the New-York *Herald*, informs us that in March, 1866, he left the coast of Eastern Africa below Zanzibar, and was proceeding up the Boyuma River, when the report of the existence of hostile tribes farther on reached the party, which caused most of his twenty-eight men to desert; and as an excuse for their cowardice they spread the report of his death, which was so widely circulated. The Doctor, however, in spite of this defection, continued his journey around by the south end of Nyanza Lake, and finally reached the Chambezi River, which he skirted for 700 miles, and became satisfied that this was the real source of the Nile, making the total length of that river 2600 miles. He also ascertained that Lake Tanganyika was not a tributary of this river. After arriving within 180 miles of the head of the Chambezi, he was obliged to return to Ujiji for want of supplies, and was there met by the commander of the *Herald* expedition.

It was Livingstone's intention, when Stanley left, in March, 1872, to explore the north shore of the Tanganyika Lake, and the remaining 180 miles of the Chambezi, which he expected would occupy him for the next two years. (92)

CHICAGO FIRE MONUMENT.

IN the account given of the great conflagration at Chicago, in SCIENCE RECORD for 1872, mention was made of the immense number of iron safes that proved worthless, under the terrible ordeal to which they were subjected: and a suggestion was there given for the erection of a grand monument to be composed of the *débris* of the safes, sacred to the memory of their manufacturers, and of the worthless insurance companies, and the wretched police and fire departments—institutions which proved so sadly deficient at the critical moment. That suggestion has been actually adopted, and the monument is now being erected in Central Park, Chicago, at the termination of Washington Street. The corner-stone was laid with civic and masonic honors. We give an engraving of the monument from a photograph of the design.

The structure will be singular in shape and material. The superstructure is circular in form, and composed of a series of columns connected by arches, allowing full passage to spectators. Above this, and rising to a considerable height, is the shaft, curiously fashioned from a huge collection of portions of burnt safes that were dug from the *débris*. The columns, arches, and main objects of architectural embellishment are likewise relics of the fire



—marble cornices and granite remains of every possible size and shape.

The idea of perpetuating the conflagration by the salamander properties with which it played so furiously was extremely happy, and when completed, the monument will need no descriptive legend to tell its story. Every portion will exhibit the heat of the flames, and the strange structure will testify to the industry and pluck of the stricken city.

HORTICULTURAL MANURE.

DR. JEANNEL.—This is made as follows: Nitrate of ammonia, 400 parts; biphosphate of ammonia, 200; nitrate of potassa, 250; chloride of ammonium, 50; sulphate of lime, 60; sulphate of iron, 40. These ingredients are pulverized, well mixed, and kept in well-closed dry bottles. 4 grms. of this mixture are dissolved in 1 litre of water, and to each plant (in pots or in open ground) is given weekly a dose of from 25 to 50 or, even in some cases, 100 grms. It is best to pour the liquid in the saucers in which the pots are placed.

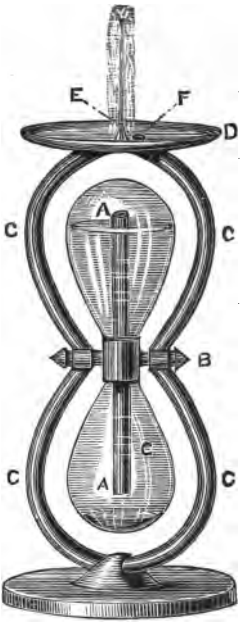
A NEWLY-DISCOVERED HEAD OF JUNO.

ANOTHER precious discovery has been made at the Prætorian Camp, Rome, namely, a fine head of Juno, almost intact, and with a remarkable purity of outline. The nose is nearly perfect—a remarkable occurrence—having received only a slight knock from the pick of the workman who lighted on it, but the little chip sprung off near the root and does not destroy the beauty of the face. This valuable relic, brought to light in the excavations now going on for the enlargement of the Via San Lorenzo, appears to belong to the end of the second century or the beginning of the third. (25)

PINE lumber is shipped at New-York to nearly all foreign countries, the following especially: Africa, Amsterdam, Antwerp, Argentine Republic, Beyrout, Brazil, Bremen, British Australia, British East-Indies, British Guiana, British Honduras, British West-Indies, Cadiz, Canary Islands, Central America, Chili, China, Dutch East-Indies, Dutch Guiana, Ecuador, Gibraltar, Havre, Japan, Lisbon, London, Palermo. The total number of feet shipped to foreign ports from January to July, 1872, was 15,843,532, and the value $546,552. (25)

COATING ROASTED COFFEE.—To protect roasted coffee from shrinking, and from the effects of damp, T. Cook proposes to cover it with a compound of starch, gum arabic, and essence of coffee, applied during the roasting process or immediately after.

TABLE FOUNTAIN.



AA′ are two glass bulbs resembling an hour-glass, which can be turned vertically about a central axis B. C C, which are brass supports of the basin D, are probably the pipes through which the water flows to the jet E. At the foot of this jet is a hole F through which the waste water flows. A is full of water, and gradually empties into A′ while the jet is playing. As soon as the fountain ceases to play, its action may be renewed by inverting A′. (The tube G passes through the middle of AA′, and nearly touches the bottom of the chambers.)

This fountain works on substantially the same principle as the ancient curiosity known as Tantalus Cup, in which syphon tubes were concealed. Many other ingenious forms of these fountains have been made, and, when well made, some very beautiful results are obtained.

FLUORESCENT LIGHT.

By Prof. Henry Morton.—In addition to the vast field already occupied by the spectroscope as a means of discrimination, another useful though limited range may be given to it in connection with that remarkable property of matter, in relation to light, known as fluorescence. This action was first thoroughly investigated by Professor Stokes, who, in 1852, published in the *Philosophical Transactions* an admirable memoir on the subject, in which he conclusively showed that when blue or violet light fell on a vast number of substances it was absorbed and re-emitted; with, however, in all cases, a lowering of its rate of vibration, or, in other words, a change of its color, from blue or violet to green, yellow, orange, or red. His observations showed that the colors emitted by different substances varied greatly, and when analyzed with a prism broke up, in many cases, into characteristic groups of bright-colored shaded bands. The spectroscope

had not then, however, been introduced, and having no means of exact measurement, its results were rather qualitative than quantitative.

Becquerel worked in the same direction and in the same way, until very recently, and several other observers had added more or less to our knowledge on special points.

Some time since it occurred to me that, if accurate measurements were made of the bright bands found in the spectra of fluorescent light emitted by various bodies, these might become a means of recognition, and thus of qualitative analysis. With the assistance of Dr. H. C. Bolton, who kindly supplied me with a very large number of fluorescent salts, I carried out during the past summer a system of observation which developed several interesting results, among which, for example, was this, that the presence of impurities could be detected in certain chemical salts without so much as opening the bottles in which they were sold.

OYSTER NURSERIES.

IT is said to be impossible to propagate oysters on our Pacific coast because the young ones after leaving the parent shell float about loose and are carried off by the tide. B. F. Lyford proposes to remedy this by providing nurseries which are separated from the sea by a wall in which are openings having valves to allow free ingress to the tide, but prevent its egress. A series of floating "skimmers" are used through which the water may ebb, but as the oysters are near the bottom they do not pass out with it. In the pond or nursery gunny bags and other fibrous materials are suspended, and the bottom is covered with brush, tiles, or other articles to which the oysters are likely to adhere. After the oysters have attained sufficient size, these materials, with the adhering oysters, are separated into small quantities, and planted in a suitable estuary or beach, to complete their growth and fatten.

THE COLORS OF INSECTS.

DR. H. HAGEN states that the colors of insects are of three distinct kinds, viz., colors produced by interference of light, colors of the epidermis, and colors of the hypodermis. Colors due to interference may be produced in two different ways: either by thin superposed lamellæ, as in the wings of Dyptera or Neuroptera, or by many very fine lines or striæ in very near juxtaposition, as in *Apatura* and other color-changing insects; these colors are only optical phenomena, and differ in this respect from both of

the other kinds. The epidermal colors belong to the pigment deposited in the cells of the chitinized external skin or epidermis. They are mostly metallic blue, green, bronze, golden, silver, black, brown, and perhaps more rarely red. They are very easily recognized, being persistent and never obliterated or changed after death. The hypodermal colors are situated in the non-chitinized and soft layer called the hypodermis by Weismann. They are mostly brighter and lighter, light blue or green, yellow, milk-white, orange, and all the shades between. The hypodermal colors in the body of the insects fade or change, or are obliterated after death. The hypodermal colors are very often different in males and females of the same species; the epidermal colors rarely differ. The hypodermal colors may change or be altered in some way in a male or female during its lifetime by sexual or other influences; the epidermal colors never change; the so-called "mimetic" colors are probably hypodermal. The hypodermal colors appear to be due to a kind of photographic action; the epidermal to a chemical process of combustion or oxidation.

COAL.

IN a paper read before the American Association for the Advancement of Science, by Professor Andrews, he stated there were three leading varieties of bituminous coal—the ordinary resinous or caking coal, the splint, and the cannel coal. These pass into each other by almost imperceptible gradations. The resinous coal seems to be the normal condition which the buried vegetation first assumes; the splint and cannel are modified forms, the cannel coal having lost all trace of structure, and containing no organized form except *Stigmaria*, which is very abundant. The ash of coal is the original inorganic matter of vegetation, often increased by sedimentary matter in the marsh during the formation of coal.

(10)

THE coal-mining statistics of Belgium show that in 1852 miners were paid thirty-five cents a ton and in 1872 sixty cents a ton, an increase of over seventy per cent. During this period of twenty years each workman has, by the improved tools and appliances provided, been enabled to increase the amount of coal mined, per man, from one hundred and thirty-one tons to one hundred and forty-five tons. The profits to owners per ton have diminished, owing to increase of expenses. The quantity of coal mined in Belgium in 1836 was 773,000 tons; in 1871, 4,186,000 tons.

REMOVAL OF INK-STAINS.

DR. BOTTGER recommends the use of pyrophosphate of soda for this purpose, the salt to be applied in concentrated solution. The recent ink-stains are readily removed, but older stains require washing and rubbing with the solution for a long time.

DISINFECTION OF SPONGES.

BY M. LERICHE.—The sponges are first impregnated with a solution of 4 parts of permanganate of potassa in 100 parts of water, and next placed in a solution of 25 parts of sulphurous acid to 100 of water, and finally well washed with water. By this treatment sponges acquire their original condition, and even their marine odor, although they may have been soaked in pus and infectious matter.

WATER-PROOF AND MOTH-PROOF CLOTH.

TEN pounds of alum and ten of lead-acetate are dissolved in sufficient warm water, and the mixture allowed to stand till the precipitate of lead sulphate has settled down. The clear solution containing aluminium acetate is poured off, and mixed with five hundred measures of water, in which dissolved isinglass is stirred up. The articles to be made water-proof are steeped in this mixture for twelve hours, after which they are dried, and subjected to pressure. Clothing made of such material does not interfere with the perspiration of the body.

NEW HORSE-SHOE NAILS.

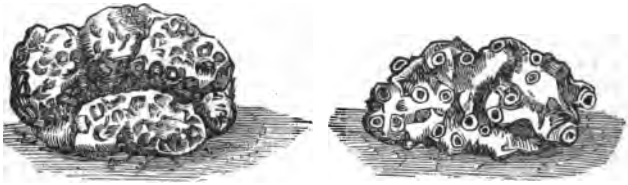
A HORSE-SHOE nail introduced by Joseph Jorey is formed with a large projecting head, so as to form a calk as well as a nail. One side of the head or calk is made of harder metal than the other, so as to wear unevenly and thus always retain its edge. The shoes employed with these nails have large recesses into which the heads are partly sunk, so as to form a support for the calks.

SPITTOONS.—For the convenience of invalids, Antonio Quirola arranges a spittoon beneath the seat of a chair in such a manner that, by touching a spring, a portion of the side rail swings around, bringing the spittoon in position for use, and on returning the rail to its former position the utensil is concealed.

EAR-MUFFS.—With these articles, as ordinarily made, there is considerable difficulty in hearing, and to obviate this Charles Sedgwick proposes that they shall have perforations in the centre to readily admit the passage of sound.

MANNA OF THE DESERT—AN EDIBLE LICHEN.

THE discovery of this curious plant is due to Pallas, who named it *Lichen esculentus*, and described and figured it in his great work, "Reise durch verschied. Provinzen des Russichen Reiches," (1776.) The figures are of the natural size. "Corpuscules free, oblong, composed of a convolute, thick coriaceous white crust, externally wrinkled and tuberculose, gray or pale ash-color. Apothecia rare, immersed, excavated, somewhat prominent, like warts. Occurs thickly among stones in the very driest limestone hills of the Tartarian desert, scarcely distinguishable from small stones, except by the expert." In the modern system the plant belongs to the genus *Lecanora*, and will stand as *Lecanora esculenta*, Duf.: *Placodium Susufii* also being a synonym.

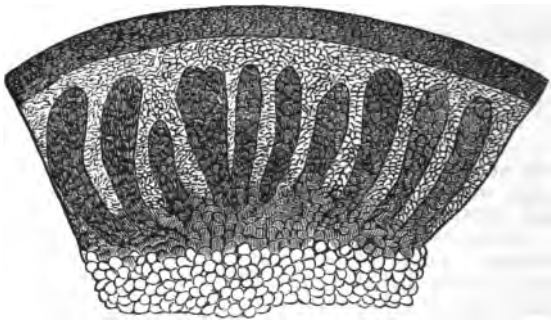


LICHEN ESCULENTUS, (BARREN AND FERTILE SPECIMENS.)

Mr. Berkeley tells us that Dr. Arthaud published a pamphlet to prove that this must have been the manna with which the Israelites were fed, and the same view is supported by Giles Munby, Esq., in a paper on the botanical productions of the kingdom of Algiers, read at Birmingham in 1849, before the British Association for the Advancement of Science.

Mr. Munby resided many years in Algeria, and he tells us that it covers the sand in some parts, and grows during the night like mushrooms, and also that the French soldiers, during an expedition south of Constantine, subsisted on it for some days, cooking it in various ways and making into bread.

Presuming that the lichen is the same as that on which the children of Israel were fed, there is really little inconsistent with the Scripture account; allowing that the manna was miraculously supplied, it might still be brought about by natural agency, for Mr. Berkeley further mentions that, lying loose on the ground, without any attachment, it is easily rolled along by the wind, and sometimes piled together in strata several inches in thickness. Nay, more, it is still occasionally rained from heaven, being carried up by whirlwinds, and after traversing the air for



SECTION OF THE MARGIN OF A LOBULE FROM ALGERIAN SPECIMENS, × 80.

many miles, falls precisely as the showers of fish, frogs, and gnats' larvæ, which afford sensational paragraphs for our own newspapers. Such a shower of these lichens fell about twenty years ago at Erzeroum, during a time of great scarcity; this bread from heaven affording opportune relief to the inhabitants. (16)

OSTRICHES.

IN Buenos Ayres papers the government is urged to take strenuous measures to stop the killing of ostriches, (*Rhea Americana.*) The extensive slaughter of these birds, now going on, may be judged from the fact that in the month of August 9200 lbs. of American ostrich feathers (which enter into commerce in Europe as vulture feathers) were exported from Buenos Ayres, including 7200 lbs. from the Banda Oriental. The Jesuits of Paraguay, according to Sr. Ojeda, had 1000 tame ostriches, which used to come every day at the twelve o'clock bell to get corn. Dr. Vavasour had a flock of tame ostriches at Pichinango, which used to go out in the fields and return every night to sleep in the farm-buildings. Donna Nicanora Castriz had some which would come and lay their eggs in her lap, hatching them in her bed-room. Ostriches are now very rare in Paraguay or Corientes, but more numerous in Entre Rios, Banda Oriental, and Buenos Ayres. A prize of £60 sterling is offered by the Uruguay Rural Society to the person that can show in 1874 the largest number of tame ostriches. As the African ostrich has been successfully domesticated and reared for its feathers in both North and South-Africa, there is no reason why attention should not be given to the American ostrich for the feathers, which are in much request.

BIOGRAPHY.

PROFESSOR JOSEPH HENRY.

THE steel-plate engraving of this distinguished man of science, which forms the frontispiece of our volume, is from a recent photograph, and is a most excellent likeness. Professor Henry is now in the seventy-sixth year of his age. There are few individuals in whose personal appearance the advance of life has made so little change. His hand-writing is still as smooth as ever, as a glance at his freshly signed autograph readily shows. He comes from long-lived, hardy ancestors, of Scotch origin, who lived to number their years among the nineties.

Professor Henry was born in Albany, N. Y., December 17th, 1797, and it was here that his early years were spent. He had only the ordinary common-school education, and in youth exhibited no particular bent of mind or special inclination for study. But he finally entered the Albany Academy, determined to know something, and soon qualified himself sufficiently to be able to get a position as a country-school teacher, which he held for part of a year, and then returned for further study at the Academy. Here he assisted Dr. Beck in the laboratory, and began those studies in the practical sciences which he subsequently continued with such distinguished success.

In 1826, he became professor of mathematics at the Albany Academy. His spare time was devoted to original investigations on electricity and magnetism, the first regular series on natural philosophy which had been prosecuted in this country since the days of Franklin. Accounts of some of these experiments and of his electro-magnetic motor machines were published in *Silliman's Journal* in 1831. These researches made him favorably known, not only in this country, but also in Europe, and led to his call, in 1832, to the chair of natural philosophy in the College of New-Jersey, at Princeton.

In 1835, he was elected professor of natural philosophy in the University of Virginia.

In 1846, he became connected with the Smithsonian Institute, at Washington, as secretary or director, which position he still occupies. He is also president of the National Academy of Sciences, established by an act of Congress in 1863, to advance science and to report upon such questions of a scientific character as might be con-

nected with the operations of the government. He is a member of various societies in this country and abroad, and has several times received the degree of LL.D., the last time from Cambridge, Massachusetts. He married Miss Alexander, of Schenectady, the sister of Professor Alexander, of Princeton.

The limit of our space prevents us from a review of the many scientific investigations and discoveries of which Professor Henry is the author. We will only enumerate some of those relating to electricity, as follows:

1. The development, for the first time, of magnetic power sufficient to sustain tons in weight, in soft iron, by a comparatively feeble galvanic current.

2. The first application of electro-magnetism as a power to produce continued motion in a machine.

3. An exposition of the method by which electro-magnetism might be employed in transmitting power to a distance, and the demonstration of the practicability of an electro-magnetic telegraph, which, without these discoveries, was impossible.

4. The discovery of the induction of an electric current in a long wire upon itself, or the means of increasing the intensity of a current by the use of a spiral conductor.

5. The method of inducing a current of quantity from one of intensity, and *vice versa*.

6. The discovery of currents of induction of different orders, and of the neutralization of the induction by the interposition of plates of metal.

7. The discovery that the discharge of a Leyden jar consists of a series of oscillations backward and forward until equilibrium is restored.

8. The induction of a current of electricity from lightning at a great distance, and proof that the discharge from a thunder-cloud also consists of a series of oscillations.

9. The oscillating condition of a lightning-rod while transmitting a discharge of electricity from the clouds causing it, though in perfect connection with the earth, to emit sparks of sufficient intensity to ignite combustible substances.

In relation to the electro-magnetic telegraph, it has been clearly shown that Professor Henry was the originator of the only practical method of sending telegraph signals through long distances, and that he put into actual operation a telegraph of this kind previous to any other person. It further appears that Morse, both personally and through his agents, applied to and obtained from Professor Henry the description of his apparatus and the proper information needed to enable Morse to make an

operating telegraph instrument. The inventions of Henry are all embodied in the Morse instrument, and the latter was in no sense an original inventor. He was simply a user and introducer of Henry's discoveries.

If the devices and discoveries of Henry were to-day discarded, it would be impossible, in a commercial sense, to send telegraph messages. But the instruments of Morse might be wholly discarded without serious difficulty. Indeed, the instrument upon which Morse most strenuously based his claims as originator of the telegraph, namely, the recording instrument, or stylus, which produced a signal on paper—this instrument has gone almost entirely out of use. Telegraphing, in this country at least, is now chiefly done by sound, by causing a bar to strike on a sonorous body; and this was the form of telegraph instrument originally invented and put in operation by Henry long prior to Morse's appearance as a worker in telegraphy. Morse and his friends used to argue, before sound-telegraphs came into vogue, that the only sort of instrument fit to be called a telegraph was a device which registered its signals, so that they could be preserved; and as Morse's instrument was the first to register the signals it ought to be regarded as the first telegraph, and Morse ought accordingly to be credited as the originator of the telegraph. But that reasoning is no longer tenable—the honor of originating the telegraph belongs in truth to Joseph Henry; and if Congress were now to do for him what it has done for Professor Page, namely, grant him a patent for his inventions, although they have been in public use for many years, Professor Henry would enjoy a monopoly as patentee of all the telegraphs, railway signals, fire-alarms, and electro-magnetic machines of every kind now used in the United States, for he was the father of them all.

The least that Congress can do at this late day is to appropriate a liberal reward to Professor Henry in recognition of the vast benefits he has conferred upon the country by his various discoveries, and especially as the original author of the electro-magnetic telegraph and the many other forms of electro-magnetic machinery now employed in the industrial arts.

Among other researches by Prof. Henry, we may mention the reflection of heat from concave mirrors of ice, and its application to the source of heat derived from the moon. Also observations on the temperature of the sun spots, and of different portions of the sun's disk. Also experiments on heat radiated from clouds, and from animals in distant fields.

SAMUEL FINLEY BREESE MORSE.

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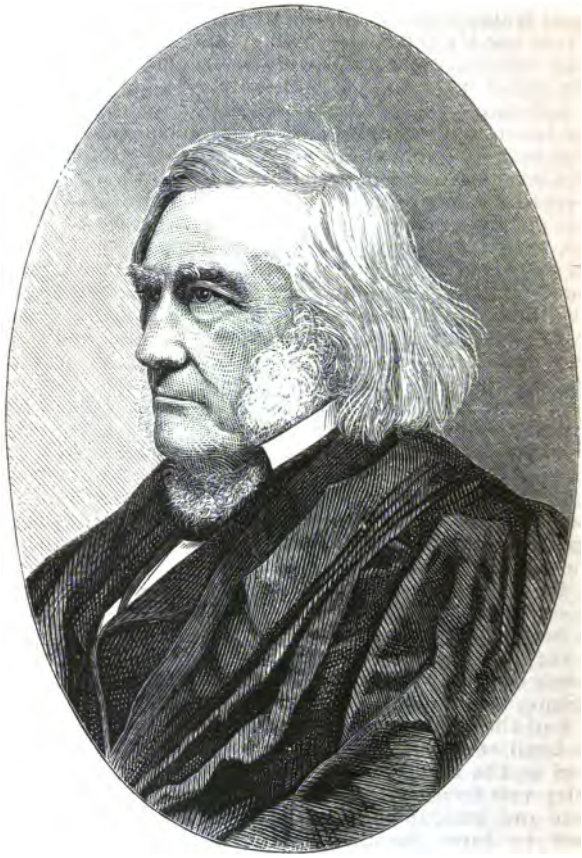
SAMUEL FINLEY BREESE MORSE.

AMONG the distinguished persons who have passed from among us during the year just closed, is Samuel Finley Breese Morse, whose name will stand in the annals of history as one of the foremost promoters of the electric telegraph. He died at his residence in the city of New-York, on the 2d of April, 1872, at the age of 81, having been born at Charlestown, Mass., April 27th, 1791. He was educated at Yale College, New-Haven, Ct., and adopted art as his profession, in which he exhibited rare abilities. Several years of his artistic life were spent in London, where he enjoyed the instructions of those celebrated artists Benjamin West and Washington Allston.

It was on a homeward passage from Europe in the year 1832, in the sailing-ship Sully—for that was before the days of ocean steam-navigation—that his mind appears to have been directed towards the construction of a telegraph instrument; and he seems to have been stimulated in the matter at this time by a certain sort of rivalry in talking up the subject with his fellow-passengers. Especially was this the case in respect to one of those passengers, Dr. Charles T. Jackson, who was pretty well posted on the subject of electricity at that time, and imparted much useful information to Morse. Indeed, it has been claimed that Morse borrowed nearly all the ideas he had upon the subject from Jackson. But, after all, that matters but little, since both were borrowers from others, and neither were original discoverers of any thing new in electricity. The fame of Morse rests upon his success as the introducer of the telegraph into the service of the public. He devised a simple form of telegraph instrument, received his patents, and made efforts to introduce it. In this he enjoyed the assistance of aid from the public treasury. Congress appropriated money to build the first telegraph line from Washington to Baltimore. This line, 40 miles in length, was set in operation May 27th, 1844, when Morse was in his 54th year. From that date the success of the telegraph was assured, the improvement made steady progress, in due time became a success, and the inventor received honors and wealth.

In 1871, a bronze statue in his honor was erected in Central Park, New-York, and on that occasion the venerable inventor, still hale and erect, delivered an address to the assembled multitude.

We have selected an early portrait for our engraving—that of the artist Schussele, painted from life soon after the completion of the first telegraph line. The likeness is excellent, and gives a good idea of his personal appearance at that time.



SAMUEL NELSON.

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JUDGE NELSON.

By E. W. Stoughton:—The resignation of the Hon. Samuel Nelson, senior Associate Justice of the Supreme Court of the United States, after an uninterrupted service on the bench of nearly fifty years, furnishes an occasion rarely found in history for presenting to our bench, our bar, and country an illustration of the benefits which judicial labor and example may confer, when inspired and guided by grand common sense united with profound and varied learning, great experience, and a stern, unfaltering resolve to administer justice with an even hand. The public career of this great judge is closed. At the age of eighty years, with his mental faculties all unimpaired; with a memory so capacious and sound that he can restate complicated facts in cases long since heard by him and forgotten by the counsel concerned in them; with a mind stored with knowledge from long converse with books and men; with a body still healthy and strong; with a cheerful spirit, and tastes refined and cultivated, he has gone, as did the great Lord Mansfield at a still more advanced age, to the enjoyments he so well loves, of farm and garden and books, of home, family, friends. He has left the bench, not because the grasp and comprehension of grave and difficult questions are beyond his mastery, but because he feared his bodily strength might be unequal to the performance of judicial work.

The public life of Judge Nelson commenced early. In 1821, he was a member of the convention which framed the Constitution of the State of New-York; and in April, 1823, he was appointed a Circuit Judge.

In 1845, Judge Nelson, who had already as Circuit Judge, as Associate, and Chief-Justice of the Supreme Court of the State, won solid judicial fame, was transferred to the Bench of the Supreme Court of the United States.

So familiar had he become with the jurisprudence involved in the administration of the Patent Laws of this country—so thoroughly did he investigate questions of science and mechanics—and so sound a judgment was he known to form on these subjects, that his opinions concerning them were by courts and counsel accepted as of greater authority than those of any other judge.

On questions of admiralty and maritime law he came to be considered a great authority, and the most eminent members of the American bar will unite in saying that, take him for all in all, he may be favorably compared with any magistrate living or dead.

GUSTAV ROBERT KIRCHHOFF.

THERE are few discoveries of modern times that have created more surprise and wonder than that of spectrum analysis, and none that in so short a time has been found to be of such importance in chemistry and astronomy, or that have contributed so largely to the expansion of our ideas of the universe. By the method of spectrum analysis the chemist is enabled to detect the presence of substances in the most minute quantities, and this even when all other methods fail; it has enlarged our views about the constitution of matter, and, although it has only been known since 1860, it has led to the discovery of several new elements. By the application of spectrum analysis to astronomy, the observer is enabled with an unexpected degree of certainty to draw conclusions as to the nature of the atmosphere, of the sun, the fixed stars, and those wonderful bodies known as nebulæ. Applied to celestial physics, it has become the means to measure the swiftness of the solar wind-storm, to estimate the pressure of the photosphere, and to determine the motion of fixed stars. In fact, no invention since the discovery of the telescope has exerted a greater influence upon the progress of astronomy than that of the spectroscope. This discovery is largely due to the subject of our biographical notice.

Gustav Robert Kirchhoff was born on March 12th, 1824, in Königsberg, the second capital of the kingdom of Prussia, and well known among students for long being the residence of the celebrated philosopher Kant and the geographer Gaspari. Kirchhoff entered the university of his native city at the age of eighteen, and studied mathematics and physics. In 1847, he went to Berlin; and in the following year he entered there upon his career as private tutor at the university. In 1850, he was nominated extra professor of physics in the University of Breslau, to which his friend Bunsen removed a year later. In 1854, he was nominated ordinary professor in the University of Heidelberg. This position he still occupies. The earlier researches of Kirchhoff were devoted to various phenomena of electricity and galvanism. He made interesting observations upon electricity, on the expansion and other physical properties of bodies, and lastly, he devoted considerable time to the study of the tension of steam.

The observations which led to the greatest of Kirchhoff's discoveries may be summed up as follows: Newton in 1675 first showed that the white sunlight is a compound of light of many different colors. He proved this by al-

GUSTAV ROBERT KIRCHHOFF.

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lowing solar light to pass through a prism placed behind a small aperture in a screen. He found on the opposite wall, the room being dark, a rainbow-tinted streak or ribbon of light, which is known as the solar spectrum. Wollaston, in 1808, showed that this streak of light was not continuous, but that it was interrupted by gaps or dark lines. Having observed the spectrum directly with the unaided eye, he had seen but two gaps; but Fraunhofer, a German, in 1814, saw and mapped not less than 576 lines. He saw that the spectra of the fixed stars exhibit dark lines, resembling those in the sun; but he observed that some lines were wanting in the star spectra, and, on the other hand, he found in them several new lines.

Let us next examine the prismatic images given by different terrestrial bodies. John W. Draper, of this city, discovered that an incandescent solid or fluid gives a continuous spectrum, namely, a rainbow-tinted ribbon of light not interrupted by gaps. Glowing vapors, however, yield altogether different spectra, inasmuch as they only consist of colored lines or bands. Now, it had been noticed by Fraunhofer that the light from a candle (which contains the almost ubiquitous element, sodium) gives two yellow lines close together, which coincide exactly in position with two dark lines in the orange-colored part of the solar spectrum. Kirchhoff was the first who demonstrated by experiment that the two yellow lines were really produced by sodium-vapors, and, by allowing sunlight to shine through a sodium-flame, he proved that the two dark lines in the orange-colored part coincide exactly with the two yellow lines produced by sodium-vapor alone. The interpretation of this fact is founded on the existence of a law which is thus worded by Professor Roscoe: "Every substance which emits at a given temperature certain kinds of light must possess the power at the same temperature of absorbing the same kinds of light."

Kirchhoff, in common with Bunsen, now commenced to experiment with other elements, such as potassium, lithium, calcium, strontium, barium, iron, etc. They proved that when the calcium light, which, like all glowing solids, yields a continuous spectrum, shines through flames of those elements, a number of dark lines appear across the continuous spectrum, of which every one had its counterpart in the rainbow-tinted image of the sun. They compared, for instance, the spectrum of the incandescent vapors of iron with the solar spectrum, and found that sixty bright lines, which it gives, coincide exactly in position with an equal number of dark lines in the solar spectrum.

"Hence," remarks Kirchhoff, "this coincidence must be produced by some cause, and a cause can be assigned which affords a perfect explanation of the phenomenon. The observed phenomenon may be explained by the supposition that the rays of light, which form the solar spectrum, have passed through the vapors of iron, and have thus suffered the absorption which the vapor of iron must exert. As this is the only assignable cause of the coincidence, the supposition appears to be a necessary one. These iron-vapors might be contained either in the atmosphere of the sun or that of the earth. But it is not easy to understand how our atmosphere can contain such a quantity of iron-vapor as would produce the very distinct absorption lines which we see in the solar spectrum, and this supposition is rendered still less probable by the fact that these lines do not appreciably alter when the sun approaches the horizon. It does not, on the other hand, seem at all unlikely, owing to the high temperature which we must suppose the sun's atmosphere to possess, that such vapors should be present in it. Hence, the observations of the solar spectrum appear to me to prove the presence of iron-vapor in the solar atmosphere with as great a degree of certainty as we can attain in any question of natural science.

It was in 1860 that he published his memoir on the relation between the emissive and absorptive powers of bodies for heat, as well as light, in which occurs the celebrated sentence:—"*The relation between the power of emission and the power of absorption of one and the same class of rays is the same for all bodies at the same temperature,*" which will ever be distinguished as announcing one of the most important laws of nature, and which, on account of its extensive influence and universal application, will render immortal the name of its illustrious discoverer.

Kirchhoff's investigations have been published either in Crelle's *Journal für Mathematik*, or in Toggendorf's *Annalen*, which latter contains the labors of so many illustrious men. In 1870, he was offered the chair of physics in the University of Berlin, which had been vacated by the death of Magnus, but he declined. In his stead the celebrated Helmholtz, who then occupied the chair of physiology in Heidelberg, but whose reputation had become world-wide as a physicist, was nominated. Kirchhoff is one of the few corresponding members of the Academy of Sciences in Berlin. He published in 1861, as a separate work, "*Untersuchungen über das Sonnenspectrum und die Spectren der chemischen Elemente.*"

ROBERT WILHELM BUNSEN.

ROBERT WILHELM BUNSEN.

THE labors of the savant whose career we are about to portray, belong essentially to researches which are not exclusively chemical, or exclusively physical, but appertain to both, and have added largely to that branch of science known as physical chemistry. As Berzelius will always live in our memory as the founder of the electro-chemical system, Gerhardt as the discoverer of the theory of types, and Liebig as the originator of agricultural chemistry, so will Bunsen always be remembered as the one who has most contributed to the application of chemistry to physical inquiries. Like all men of great genius, the subject of our biographical notice was less occupied with the reinvestigation of phenomena and laws already known than with the exploration of new regions and the discovery of facts which, in themselves, indicated new scientific truths.

The discoveries which have done most to extend Bunsen's renown are these pertaining to spectrum analysis; but his name will always be recalled when we speak of the theories of periodical fountain-springs, or of the phenomena of the absorption and combustion of gases, or of the chemical action of the different rays of the sun.

Robert Wilhelm Bunsen was born on March 31st, 1811, in Göttingen, a town in Hanover, known by its famous university, in which his father occupied one of the chairs of languages. At the age of seventeen he entered the university of his native town, in order to pursue physical and chemical studies, and, after having passed through all the grades, he took the degree of doctor in 1833. In 1836, he removed to Cassel in order to fill the chair of chemistry at the polytechnic school of that city, which had been vacated by Woehler. Two years later, Bunsen was elected professor of chemistry in Marburg; and, in 1851, he removed in the same capacity to Breslau. In 1852, he was nominated professor of chemistry in the University of Heidelberg, which position he still holds.

His earlier labors were devoted to researches on double cyanides, on the various kakodyl compounds, and, in connection with Schischkow, on the gases of detonating compounds. He also discovered in the freshly precipitated hydrate of oxide of iron an excellent antidote for arsenic. In the domain of physics, we see him engaged in determining the specific weight of various bodies, in studying the law of the absorption of gases, and the influence of pressure upon the solidification of liquids. We owe to him important contributions relative to the combustion and diffusion of gases, etc. Bunsen is the discoverer of

the galvanic battery which bears his name, and which is now most commonly in use. Also of that wonderful instrument known as Bunsen's burner. In the summer of 1846, he undertook, with Descloizeaux, a voyage to Iceland, in order to investigate the periodicity of the fountain-springs, especially that of the great geyser. The result was that beautiful theory of the geyser eruptions which was afterward illustrated experimentally by Müller in Freiberg. In 1859, Bunsen first prepared the metal magnesium on a large scale, and showed that it yields the most brilliant artificial light known, and that its photochemical action was one thirty-sixth of that of solar light. In conjunction with Roscoe, he determined the chemical action of the various rays of the sun.

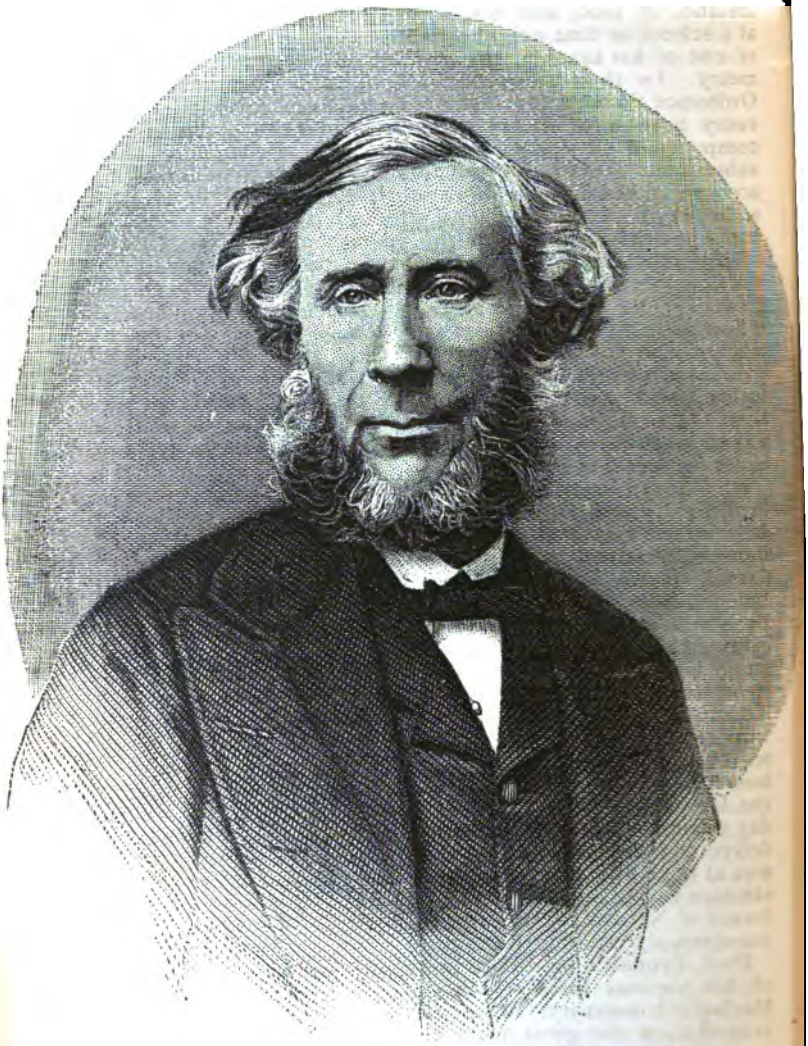
The researches of Bunsen on spectrum analysis date from the year 1860. Since that time he has contributed a large number of exhaustive memoirs on this subject to Toggendorff's *Annalen* and to the *Annalen der Chemie und Pharmacie*, besides many special volumes.

Herr Bunsen, although now in his sixty-second year, enjoys excellent health, and is still unceasing in the pursuit of his investigations. His style of lecturing is very happy, and has always attracted a large audience. His modesty is unsurpassed; and even when speaking in his lectures on spectrum analysis, he never mentions having contributed any thing to this science, but speaks only of the discoveries of his friend Kirchhoff. Among his pupils are Roscoe and Tyndall, who, as is well known, are among the most ardent laborers in the field of science.

PROFESSOR TYNDALL.

AMONG the interesting incidents of the past year was the visit to our shores, for the first time, of the distinguished Professor of the Royal Institution of London, John Tyndall. In Boston, New-York, Brooklyn, Philadelphia, and New-Haven he delivered courses of lectures before very large audiences, larger, probably, than were ever gathered for similar purposes, and his instructions were received with the deepest interest. His lectures were chiefly devoted to the elucidation of the phenomena of light, heat, and electricity, and were illustrated by practical experiments of the most brilliant character. For the accompanying portrait and biographical sketch, we are indebted to the *Popular Science Monthly*.

John Tyndall was born in the village of Leighlin Bridge,



JOHN TYNDALL.

(p. 578)

Ireland, in 1820, and his earliest education was received at a school in that neighborhood. Through the influence of one of his teachers, he acquired an early taste for geometry. In 1839, he quitted school and joined the Irish Ordnance Survey. He acquired a practical knowledge of every branch of it, becoming in turn a draughtsman, a computer, a surveyor, and trigonometrical observer. In subsequent years he turned this experience to admirable account in his investigations of alpine glaciers. In 1841, an incident occurred which, although apparently trivial, had a powerful effect upon the young man's career. One of the officials, who had become interested in Tyndall's work, asked him one day how his leisure hours were employed. The answer not being satisfactory, he rejoined, "You have five hours a day at your disposal, and this time ought to be devoted to systematic study. Had I, when at your age, had a friend to advise me, as I now advise you, instead of being in a subordinate position, I might have been at the head of the Survey." Next morning Tyndall was at his books before five o'clock, and for twelve years never swerved from the practice.

In 1848, in company with his friend Frankland, (now Prof. Frankland, of the Royal School of Chemistry,) Tyndall quitted England, and, attracted by the fame of Prof. Bunsen, repaired to the University of Marburg, in Hesse-Cassel. Prof. Tyndall had the free use of the laboratory and cabinets of this institution, with the instructions of Bunsen, Gerling, Knoblauch, and Stegman. The investigation which first made him known to the scientific world was "On the Magne-optic Properties of Crystals, and the Relation of Magnetism and Diamagnetism to Molecular Arrangement."

In 1851, Tyndall went to Berlin, and continued his researches in the laboratory of Prof. Magnus. He soon, however, returned to London, and was elected Fellow of the Royal Society in 1852. He was invited to give a Friday evening discourse at the Royal Institution, which he delivered February 14th, 1853, and was so successful that he was at once offered a position in that establishment. His election to the appointment which he now holds, of Professor of Natural Philosophy at the Royal Institution, was unanimously made in June, 1853.

Prof. Tyndall's proclivity is for philosophic physics, and all his various lines of research, since he began in the Marburg laboratory, twenty-four years ago, have converged upon the great question of the molecular constitution of matter. He has been a profound student of the correlation of forces, and of the mechanism of that material substratum through which they are manifested.

Of his characteristics as a public teacher the *Galaxy* says:

"Prof. Tyndall's manner as a lecturer is in a remarkable degree individual and unique. He never reads, but holds his audience by the power of lucid and forcible extemporaneous statement. He is not what would be called a fluent or even speaker, who keeps up a continuous strain of agreeable utterance. He is not an elegant declaimer, whose measured cadences are accompanied by graceful and appropriate gestures. He is irregular and sometimes hesitating in speech, and unstudied in gestures and movements. His habit of speaking has been formed in connection with his habit of experimenting, and this latter is so essential a feature of his platform exercises that it greatly influences his manner of public address. Clearness, force, vividness of description, felicity of illustration, and the eloquence inspired by grand conceptions, are the striking features of his style. Of a poetic and imaginative temperament, but with these traits under thorough discipline, he gives vivacity and attractiveness to accurate and solid exposition. The Royal Institution, in which he is professor, is admirably constituted for the attainment of this twofold end, providing equally for carrying out systematic original researches and for expounding their results to the select audiences that gather in its lecture-room. Sir Humphry Davy first gave it a world-wide reputation in both these departments; he was a fertile discoverer and an eloquent lecturer. Dr. Faraday succeeded him, and probably surpassed him in both of these accomplishments. The mantle of Faraday has fallen upon Tyndall, and the fame of the establishment has not suffered from the change."

In person Prof. Tyndall is a man of medium stature, lithe-built, highly vitalized, alert and noiseless in his movements; a ready and effective talker, but an excellent listener, and his manners are genial and attractive. He is socially strong, a man of the world, as well as a philosopher, and at home in all relations. But, with all his passion for experiment, he has not yet made the experiment of matrimony. He is 53 years of age. The portrait we give is an excellent likeness.

"You never hear the really philosophical say, what they are constantly charged with saying, that it is impossible for the builder of the universe to alter his work. Their business is not with the possible, but the actual; not with a world which *might* be, but with a world which *is*. They have but one desire—to know the truth. They have but one fear—to believe a lie."—TYNDALL.

Benjamin Peirce

Engraved by E. Rundel Smith, from a photograph by Southworth & Hawes.

PROFESSOR BENJAMIN PEIRCE, LL.D.

PROFESSOR PEIRCE was born in Salem, Mass., April 4th, 1809. He was graduated at Harvard College in 1829, and, after teaching two years in the Round Hill School at Northampton, was appointed Tutor in Mathematics at Cambridge in 831, University Professor of Mathematics and Natural Philosophy in 1833, and Perkins Professor of Astronomy and Mathematics in 1842. He also holds the office of Superintendent of the United States Coast Survey, a bureau which has rendered most important services in the promotion of scientific research. He is also a member of all the leading scientific societies of the world.

The mathematical powers of Professor Peirce were prominently manifested in early life. He was as a pupil of Dr. Bowditch, and the proof-sheets of the translation of the *Mécanique Céleste* passed under his scrutiny and supervision before going to press.

The first of his investigations which may be said to have compelled the notice of scientific men throughout the world was the criticism of the computations and results of Leverrier, upon which this geometer based his demonstration of the existence and place of the unknown planet to whose attraction the irregularities observed in the motions of Uranus were to be attributed.

Among the discoveries and important investigations of Benjamin Peirce are especially to be named his theory of the tails of comets, published in the *Astronomical Journal*, showing the mode and laws of their formation; his methods of investigating terrestrial longitudes and the motion of the moon's limit by means of occultations of the Pleiades, published in the report of the Superintendent of the Coast Survey; his researches upon personal equation, showing the existence and means of measurement of a new and before unrecognized form of personal error in observations "by eye and ear," arising from the proclivity of every individual to award an undue prominence to particular fractions of the second; and the singular and valuable criterion for the Rejection of Doubtful Observations, by means of which the propriety of excluding apparently discordant observations from a series is definitely determined in each individual case, by the mathematical laws of probability, and removed from all arbitrary or uncertain judgment of the computer. He has investigated the forms of equilibrium of a ring or link containing a fluid, researches which confirm one of his favorite theory of analytic morphology, the trigonometric series of numbers, and the curious and elegant solution of the celebrated "school-girl puzzle," to which its author had found no symmetrical solution.

Benjamin Peirce

PROFESSOR BENJAMIN PEIRCE, LL.D.

PROFESSOR PEIRCE was born in Salem, Mass., April 4th, 99. He was graduated at Harvard College in 1829, and, er teaching two years in the Round Hill School at rthampton, was appointed Tutor in Mathematics at mbridge in 1831, University Professor of Mathematics d Natural Philosophy in 1833, and Perkins Professor of tronomy and Mathematics in 1842. He also holds the ice of Superintendent of the United States Coast Sur- y, a bureau which has rendered most important services the promotion of scientific research. He is also a mber of all the leading scientific societies of the world. The mathematical powers of Professor Peirce were minently manifested in early life. He was a pupil of . Bowditch, and the proof-sheets of the translation of *Mécanique Céleste* passed under his scrutiny and super- ion before going to press.

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PROFESSOR JAMES D. DANA.

To Prof. Dana must be assigned an eminent position in American science, as he is an acknowledged master in the three extensive departments of mineralogy, geology, and zoölogy, having made original investigations of great value in all these fields of study. He was born in 1813, in Utica, New-York, where he passed the first years of his life. He had an early inclination to the sciences. At seventeen years of age he entered Yale College, and graduated with honor.

In 1836, he was appointed mineralogist and geologist of the exploring expedition sent by the Government of the the United States to the Southern and Pacific oceans. The five vessels of the squadron, under the command of Commodore Wilkes, sailed in 1838, on a voyage around the world. After extensive explorations, and suffering shipwreck, moreover, at the mouth of the Columbia River, in Oregon, Mr. Dana returned home in 1842. The rare opportunities which this voyage afforded for scientific observation had been well improved.

Before going to the Pacific, he published, in 1837, the first edition of his "Mineralogy," of which the fifth and last edition appeared in 1868. This is a work of high repute, both in America and Europe.

His first publication connected with his observations in the exploring expedition was a "Report on Zoöphytes," which appeared in 1846, a quarto volume of 740 pages, with an atlas of 61 folio plates.

The second work in the same series was a "Report on the Geology of the Pacific," published in 1849, a quarto volume of 756 pages, with an atlas of 21 plates.

The third work pertaining to this Government exploring expedition, was a "Report on Crustacea," which appeared in 1852–54—the text, 1620 pages quarto; the atlas, 96 plates in folio: 680 species are described in this work, of which 658 are new. With few exceptions, the drawings in these atlases were made by Mr. Dana himself.

While engaged in preparing the last two of these reports, Mr. Dana has been the active editor of the *American Journal of Science and Arts.*

He is also Silliman Professor of Natural History and Geology in Yale College, to which place he was elected in 1850.

He is the author of a large number of most valuable, interesting, and original scientific papers and volumes.

Prof. Dana's last work, "Corals and Coral Islands," 399 pages, with 279 cuts, was published in 1872.

James D. Davis

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James D. Dana

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Improved Champion Spring-Mattress.

THE sum total of human experience on the subject shows that the bed question is one of great importance to every body; and that upon the wisdom of one's choice of bedding material depends much of comfort, health, and even the prolongation of life. A badly-composed bed is but too often the breeding-place of contagion and disease.

Good feathers and curled hair, in abundant quantities, make good beds; but their organic substance renders them unhealthy; and the best medical authorities discourage their use. A capital substitute for them has been found in the elastic properties of metal; and the subject of our illustration is the very latest improvement in this line—the Champion Spring-Bed—which rivals in its softness the old-fashioned down and hair, embodying, likewise, all the other good qualities that experience has shown to be desirable.

This bed is composed of one hundred and ninety-two beautiful steel springs, comprising twelve hundred coils, drawn and tempered with accuracy, yielding and pliable like watch-springs, the helices united by metalic clamps, and the whole combined with special reference to strength and durability.

The large number of springs employed—from three to six times more than are to be found in any other mattress—imparts to this bed an even elasticity and general softness which is a peculiar characteristic, besides preventing that sinking down of the bed in one spot, and that down-hill feeling of the surface, or sloping toward the place where the greatest weight rests—defects that are common to most of the ordinary spring-beds.

Another striking advantage of this bed is its remarkable flexibility.

Its extreme lightness is a distinctive and important quality; the total weight of a first-class double bed being only twenty-five pounds. A child may carry it; any woman may lift it with one hand. Housekeepers will appreciate this quality, for they can remove and place the bed wherever they require as easily as if it were a bolster.

Another excellent feature is its perfect security against corrosion, the springs being inlaid with a firm waterproof fire-enamel, which renders the bed serviceable in every climate, hot or cold, dry or damp.

Both sides of this bed are alike; it can be used either side up, has no attached frame of wood, slats, or straps, but is soft, yielding, and flexible in every part. In summer-time it forms a cool and luxurious couch, no under-bed being required; a blanket thrown over its surface is sufficient. In cold weather, a mattress of only half the usual thickness is needed.

This bed is noiseless and durable. It is also enconomical in price, the full-sized double beds of this pattern being retailed at thirteen dollars; the smaller sizes for less. Rolled up for transport, as shown in our engraving, it forms a light, compact bundle of steel springs, which may be sent to any part of the world without risk of damage.

For dwellings, boarding-houses, seminaries, hotels, steamboats and steamships, this Champion Spring-Mattress is unequaled. Made wholly of metal of the best of steel, it can not get out of order, and it does not harbor vermin or dirt.

Sold Wholesale and Retail by the makers,

F. C. BEACH & CO.,

Factory, 279 Cherry St., New-York City.

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